METAL INDUSTRY

VOLUME 93 NUMBER 25 19 DECEMBER 1958

Nickel Report

ANNUAL nickel production capacity in the free world reached a new high level of about 262,500 tons in 1958, according to a report by Dr. John F. Thompson, chairman of the International Nickel Company of Canada, and this is expected to rise progressively in the next few years, reaching a total of about 325,000 tons in 1961. It is significant that the projected 1961 nickel production capacity will be about double the total consumption in 1958.

The greater availability of nickel during the year brought with it changes in applications, some new and others a restoration of older ones which had been in effect prior to the period of restricted civilian supplies. The steel industries continued to be the largest consumers of nickel, with stainless steels, although their total production dropped substantially, accounting for the major proportion. Free availability of nickel made it possible for alloy steel consumers to return to the higher nickel-containing types for established uses, while an ultra-high-strength nickel steel is being used in increasing quantities for landing gear components in jet aircraft, as well as in sheet form for various parts of missiles. The most important new applications were those involving heat-treated high-strength structural plates and shapes containing up to about 3 per cent nickel for bridges, pressure vessels, and hulls for naval vessels.

Nickel, nickel-copper, nickel-chromium, and the wide range of nickel-base non-ferrous alloys accounted for about 16 per cent of nickel consumption. The high-nickel precipitation-hardened alloys are finding increasing applications in the aircraft industry. A large jet aircraft, for instance, is estimated to employ about two tons or more of nickel in various alloys, of which the engines account for approximately three-quarters. Again, the choice of "Inconel X" nickel-chromium alloy for the body of the satellite "X-15" represents the first use of a heat-resisting alloy as fabricated sheet metal skin capable of withstanding the weakening effect of aerodynamic heating. Complementary to aircraft developments there has been substantial progress in the development of small gas turbines, making use of the wrought nickel-chromium as well as other high-nickel cast alloys. Heat exchanger applications continued to be the major market for cupro-nickel alloys, while there has been sustained progress in the use of nickel-containing high-tensile aluminium bronze for large marine propellers. In industrial applications of electrodeposition, important advances included the use of relatively thick nickel deposits on processing equipment to prevent product contamination and electroforming of such special products as hypersonic wind tunnel nozzles, grids, screens, and special moulds.

With regard to the outlook for the future, competition from other metals will, no doubt, be fierce, traditional civilian markets will have to be recaptured and new ones created but, assured of steady, abundant supplies of nickel at a stable price, consumers may safely plan to make increasing use of this versatile material.

The Editor extends to all his readers Good Wishes for the Christmas Season

Out of the MELTING POT

In-Fab

AN In-Fab (Inert-Fabrication) plant within a plant is now being built by the Universal-Cyclops Steel Corporation at Bridgeville, Pa. This plant carries to its logical conclusion the realization that complete control of metal-working operations must include control of the environment in which such operations are carried out. Hitherto such control has been of an *ad hoc* nature. Atmosphere control in heat-treatment furnaces, vacuum melting and casting, inert gas arc welding, air conditioning in aluminium foil rolling mills, the use of glove boxes and enclosures when dealing with reactive or hazardous metals (radioactive metals, beryllium), etc., are a few examples of such *ad hoc* control. Suggestions that the need for all these expedients could be eliminated by the radical solution of filling the factory with an inert atmosphere have not been lacking, and references to moves in that direction have appeared from time to time. The In-Fab plant mentioned above will be built as a complete shop inside the factory. It will be of $\frac{3}{16}$ in. thick welded steel sheet construction, and its equipment will include a rolling mill, crane, and horizontal impacter. It will be used to fabricate such metals as niobium, tantalum, molybdenum and tungsten, which, in air, are reactive at the hot working temperatures required. There will certainly be no risk of any reaction in the In-Fab shop, with its atmosphere of 99·995 per cent pure argon. Provision has been made to maintain this purity in spite of frequent opening and closing of the three personnel locks, an equipment lock, and a material lock, and at the same time to keep the expensive argon from leaking out of the shop. This provision involves the complete removal, purification and return of the entire atmosphere of the shop every three hours. Purification includes removal of oxygen by reaction with hydrogen (the water being removed by a dryer) and separation of the hydrogen, nitrogen, hydro-carbons, etc., by low-temperature distillation. Last but not least, the operatives who will enter the In-Fab shop through the personnel locks, will be provided with "space suits" with a piped supply of air. Incidentally, it is interesting to note that leakage of air from the suits was just as large a problem as leakage of argon into them. Air from the suits would contaminate the shop atmosphere and cause damage to the metals being processed.

Require Sorting

IN the "supply and demand" situation, one interesting line deserving re-examination is that leading to the origin of demand. Since the examination can be restricted to the present and the not-so-distant past and future, a probe into the origin of demand will not end in a "chicken-or-egg" *impasse*. Instead, it can discover quite quickly that a demand may be either natural and spontaneous or synthetic in origin. One characteristic feature of demand is that very soon after its appearing on the scene the distinctions arising from the difference in origin are dropped as unimportant, and the demand is regarded as just the demand, and as a natural demand at that. This disregard of the origins of demand is not without certain undesirable consequences. One such consequence is that, once all synthetic or created demands have lost their original characteristics of artificiality, and have been accepted as spontaneous natural demands, the meeting of them likewise changes from an arbitrarily created to a natural necessity, and since such demands can be created *ad lib* and comparatively easily, coping with the resulting "natural" necessity of meeting them is liable to become quite a problem. If it were not for this readily forthcoming disregard, which accepts every emerging demand as natural, it would be possible to nip some of these demands in the bud, and thereby avoid a load of problems later no longer avoidable. Another unfortunate consequence of this proliferation of created demands masquerading as natural, is that the comparatively few genuine natural demands tend to become hopelessly swamped, and are largely disregarded. Searching them out, identifying them, and setting about to meet them may not be as easy as creating and meeting new demands, but it is certainly something that needs doing.

Neglected

A CRITICAL, as against a fascinated, look at metallurgical applications of ultrasonics leaves one with the impression that, with the single exception of ultrasonic non-destructive testing, the ultrasonic equipment is being stretched to its limits. The use of ultrasonics in metal cleaning, for example, is a fascinating one, but some of the fascination disappears with the repeated reference to the use of the method for cleaning watch parts and suchlike objects. Much the same happens in the case of ultrasonic machining, welding and soldering. Ultrasonics have been shown to have certain desirable effects in the electro-deposition of metals, but, again, practical applications are presumably restricted by disparity between the scale on which the ultrasonics can be generated and the size of commercial plating vats and the bulk of the work being treated in them. Ultrasonic vibrations have been shown to have a desirable grain refining action on solidifying metals, but it is sufficient to visualize an average high frequency generator, with its associated piezo-electric or magnetostrictive transducer, alongside a melting furnace holding a ton or so of molten metal, in the rough and tumble of the average foundry, to understand why routine practical application is still unrealized. To these limitations must be added those imposed by the cost of the ultrasonic equipment having any appreciable size and power. A way out of this difficulty might be found by examining possibilities of the much-neglected mechanical vibrations. It is true that the vibrations produced by these methods do not have the consistency and purity (amplitude and frequency) of those generated by electronic devices, but, again, for all metallurgical applications, with the single exception of ultrasonic testing, this would not matter in the least. Mechanical generators include high-velocity gas and liquid jet generators, pulsed liquid jet generators, and gas- and liquid-operated sirens. It does not require much imagination to visualize a vibrating or pulsating jet of fluid, carrying an abrasive powder, being used for ultrasonic machining. One main advantage possessed by all jet generators is the simplicity of the power source—either a compressor pump or a source of high-speed rotary movement. If electricity must be brought in, one might note that ultrasonics can be produced by a direct current arc with alternating current superimposed on it. Ultrasonic arc welding?

Skimmer

INVESTIGATION BY DEFLECTION MEASUREMENTS ON THIN MILD STEEL STRIPS

Contraction Stresses in Sprayed Metal Deposits

By W. E. STANTON

Developments in metal spraying techniques have resulted in an ever-widening range of applications for this process, and the physical properties of the deposit are assuming a role of increasing importance. This Paper, presented at the recent International Metal Spraying Conference, discusses investigations designed to determine the stresses present in various deposits.

WITH the growing demand for thicker deposits of sprayed metals and the ever-widening scope of the process, it becomes increasingly important for the metal sprayer to have a close understanding of the physical properties of the deposits. One important property concerns forces or stresses which are set up in the deposits during spraying. It is surprising that little attention has been given to this property of sprayed metals, since investigations now in progress indicate that most metals become highly stressed during spraying, and the stresses are retained indefinitely in the deposits. The full implications of these high residual stresses are open to speculation and will, no doubt, be the subject of investigations in due course, but it is clear that they play a prominent part in the practical difficulties arising in the application of heavy deposits of the less ductile metals. This is particularly noticeable in the reclamation of flat or internal surfaces, the production of sprayed moulds, and similar processes.

Origin of Stresses

The results given in this Paper were obtained under controlled spraying conditions. Insufficient evidence is available as yet to give more than an indication of the effects of varying the spraying procedure, but it appears that residual stresses are decreased by practices which tend to give increased porosity and lower cohesive strength. This might be expected, since deposits of this kind are more easily deformed within the free space partially surrounding the deposit particles, and mass effects are therefore reduced.

Strains resulting from the working of a metal are generally confined to the vicinity of the work, but correlated strains often extend throughout the mass. The load may be applied directly from an external source or indirectly through some physical quantity such as temperature. Elastic strains do not always disappear when the load is removed, for extraneous conditions may arise from the working which prevent the metal resuming its original form. The energy expended is then stored within the metal, which is said to be under stress. The locked-in forces are referred to as residual stresses, and they may be tensile or compressive.

Dimensional changes resulting from thermal variations are largely responsible for residual stresses set up in castings and fusion welds. Metal spraying is closely related to these processes and, as might be expected, sprayed deposits are similarly affected.

Tensile stresses are set up in sprayed metals owing to contraction of the individual deposit particles as they arrive at the workpiece. Momentarily at least, molten particles are in intimate contact with cooled solid particles, and although all the particles contract in the same proportions, the fact that there is a time lapse between the deposition of one and another results in an accumulation of tensile forces. In the case of a bi-metal strip, longitudinal compressive and tensile forces are in equilibrium so long as the strip is free to deflect, but in sprayed coatings of thicknesses normally applied the deposit is entirely under tensile stress. The interface is, therefore, subject to shear stresses, and for a given adhesive strength only a certain tensile force can be tolerated in the coating, otherwise failure of the bond results. This limits the maximum thickness of any metal or alloy which can be deposited, since the tensile force is proportional to the deposit thickness.

When a sprayed metal coating is applied to only one side of a thin plate of metal, the tensile forces in the deposit produce compressive forces in the underlying metal at the interface, bringing about concavity of the supporting plate. Although this to some extent relieves the tensile stresses in the deposit, stresses persisting are still predominantly tensile. Much greater distortion occurs in deposits which have been stripped from their supporting plates, since the deposit is then free from restraint at the interface. Contraction of the mass follows, until finally the tensile stresses developed in the inner layers balance the tensile stresses in the outer layers.

Residual stresses are usually defined as the stresses existing within a body upon which no external forces are acting. They exist either as micro forces acting within the structural elements or as forces affecting the mass. The former are referred to as "textural" and the latter as "body" stresses. Both forms are often inseparably related, and although from a practical standpoint only mass effects are of direct interest to the metal sprayer, from consideration of the investigations to date it is evident that changes other than thermal contraction take place in the structural elements, having far-reaching effects on body stresses set up in deposits of certain metals.

Residual stresses cannot be present without strain, which normally takes the form of elastic tension or compression, and an internally stressed body can only be in a state of equilibrium when the forces are balanced within the mass. If the balance is upset, equilibrium can only be regained by a change in dimensions or form. The classic example of a body changing in form in this way is the bi-metal strip, in which changes in the internal forces are caused by thermal variations. Stresses cannot be measured directly, and methods used depend upon measurement of the strain produced in a body under stress.

Stress Determination

The method adopted for determining comparative body stress values of sprayed metals consisted of coating, on one face only, strips of cold rolled mild steel and then measuring the amount of deflection caused by the coating. The strips were accurately cut from plate 0·048 in. thick to a standard size of 12 in. long × 0·75 in. wide. Before spraying with the metal under test, the strips were degreased and thinly coated with molybdenum. The normal preparation by grit blasting was avoided because of the danger of distortion and the possibility of setting up compressive stresses at the strip surface.

A simple but effective apparatus was used for measuring the strip deflections, which consisted of a flat base plate carrying two vertical pillars 10 in. apart. A micrometer gauge set midway between the pillars gave accurate measurements of distance between the base plate and underside of the test strips. The micrometer and strip were incorporated in an electric bell circuit to facilitate accurate measurements. A pair of ball races mounted at the top of each pillar carried the test strip (treated face uppermost).

After the preparatory coating of molybdenum had been deposited, each strip was calibrated by measuring the deflections produced by direct loads suspended from the centre. A load of 4 lb. was first applied, which was then reduced progressively by 1 lb., the heaviest loads being applied first in case they produced a permanent set. It was found that the deflections were proportional to load within the range, and the ratio was 0·107 in/lb. The spraying was carried out with a Mark 16 pistol operating on acetylene, and the wires used were all of 2 mm. diameter.

TABLE I—DEFLECTIONS AND WEIGHT EQUIVALENTS FROM FREE STRIP TESTS

Material	Deflection (in.)	Wt. Eq. (Transverse load) (lb.)
0·9 per cent C steel	0·015	0·14
Zinc	0·026	0·24
13 per cent Cr steel	0·034	0·32
Copper	0·109	1·02
Ni/Cr/Mo steel	0·128	1·20
0·7 per cent C steel	0·132	1·25
Aluminium	0·187	1·75
0·4 per cent C steel	0·198	1·85
Bronze	0·262	2·45
Swedish iron	0·286	2·68
18/8 stainless	0·353	3·30

TABLE II—DEFLECTIONS AND WEIGHT EQUIVALENTS FROM RESTRAINED STRIP TESTS

Material	Deflection (in.)	Wt. Eq. (Transverse load) (lb.)
0·9 per cent C steel	0·015	0·14
Zinc	0·026	0·24
13 per cent Cr steel	0·026	0·24
Copper	0·085	0·80
Ni/Cr/Mo steel	0·095	0·88
Aluminium	0·102	0·96
0·7 per cent C steel	0·127	1·19
Bronze	0·128	1·20
0·4 per cent C steel	0·139	1·30
Swedish iron	0·141	1·32
18/8 stainless	0·177	1·66

Four strips were coated with each metal under test and a deposit thickness of 0·020 in. was adopted as standard throughout the tests. The results given in Table I show that the highest deflections were obtained with 18/8 stainless steel and the lowest with 0·9 per cent carbon steel. In addition to the maximum deflections are tabulated the weight equivalents, which represent the static load that would be necessary to produce a deflection equivalent to that resulting from the tensile stress in the deposit.

When subsequent tests were carried out to determine the relationship between the deflection produced in the strips and deposit thickness it was found that they were not strictly proportional. The ratio of deflection to thickness increases up to 0·015 in., and from then onwards decreases. The results from varying thicknesses of 18/8 stainless steel are given in Fig. 1.

Test strips were then sprayed whilst clamped to a rigid bar, and these gave deflections proportional to deposit thickness when the clamps were removed. As would be expected, the deflections were less than those recorded on unrestrained strips.

The variation in deflections produced in the unrestrained strips is thought to be due to the progressive deflection of the deposit during spraying. This allows some stress relief and reduces the tensile strain in the deposited particles exposed to the spray stream. Particles of equivalent volume arriving at the surface thus cover a slightly larger area than the preceding ones, and in consequence their shrinkage is accompanied by greater elastic strains. These increased strains bring about still greater deflections so that the effects are cumulative up to a given thickness which, in the case of 18/8 stainless steel, appears to be about 0·015 in. At increased thicknesses the coatings become gradually more rigid, and it appears that the rate of increase of resistance to deformation is greater than the build-up of the tensile forces. This, no doubt, applies to deposits on either restrained or unrestrained strips, since it is apparent that the curves shown in Figs. 1 and 2 will join at an unspecified point. It is assumed that both curves flatten out from this common point.

The results of a further series of tests carried out on restrained strips are more closely related to practical applications, since it is unusual to apply heavy coatings to thin or pliant materials. Deflections and weight equivalents recorded are given in Table II, and these are considered to be the more satisfactory for the calculation of residual stresses in the coatings.

The residual stresses of sprayed deposits have so far been related only to the equivalent transverse loads necessary to produce given deflections of the supporting strips. The data are useful when semi-rigid panels are to receive heavy coatings on one side only, since they indicate the amount of distortion likely to arise with different metals. They also indicate the comparative thicknesses of different metals that can be deposited before failure of adhesion might be expected. They cannot give any indication of the precise thickness of any metal at which failure would occur, since this is a function of longitudinal and lateral stresses against adhesive strength.

According to the generally accepted formula, the maximum fibre stress of the supporting strip (i.e. at the interface) can be calculated from the transverse load. Thus:—

$$\text{Max. stress} = \frac{WL}{4Z} = \frac{3\,WL}{2\,bd^2}$$

where W = Load at centre of strip

L = Length of strip between supports (10 in.)

Z = Section modulus of strip = $\left(\frac{I}{Y} = \frac{bd^2}{6}\right)$

I = Moment of inertia about neutral axis $\left(\frac{bd^3}{12}\right)$

Y = Distance from neutral axis to extreme fibre $\left(\frac{d}{2}\right)$

b = breadth of strip (in.) (0.75)

d = depth of strip (in.) (0·048)

So that when W = 1 lb.

$$\text{Max. stress} = \frac{3 \times 1 \times 10}{2 \times 0{\cdot}75 \times 0{\cdot}048^2} = 8{,}680 \text{ lb/in}^2$$

Calculated stresses from restrained strip tests are given in Fig. 3.

It might be supposed that the residual stresses in sprayed metals are directly related to thermal contraction

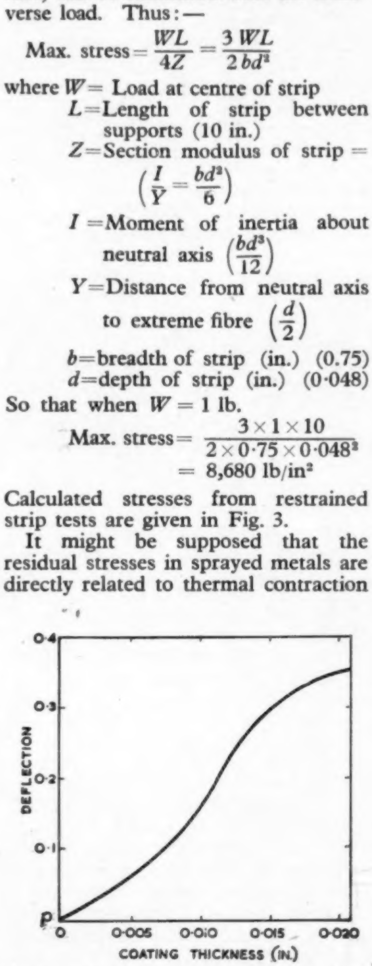
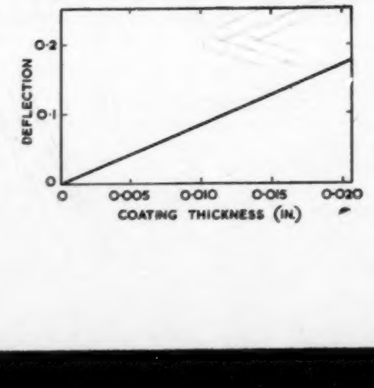


Fig. 1—Deflection of free strips resulting from stainless steel coating (18/8)

Fig. 2—Deflection of restrained strips resulting from stainless steel coating (18/8)



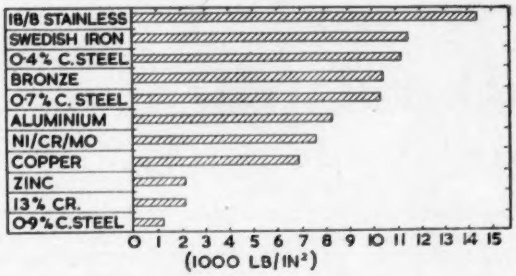


Fig. 3—Maximum fibre stress developed in restrained strip by coatings 0·020 in. thick (0·5 mm)

and melting point. That this is not the case is evident from the test results obtained. The coefficients of linear expansion of aluminium and zinc are about $24\times10^{-6}/^{\circ}$C. and $31\times10^{-6}/^{\circ}$C., respectively, whilst their melting points are at 658°C. and 419°C. A simple calculation indicates a contraction ratio between these two metals of 5:4, but the stress ratio recorded is nearer 3:1. One possible explanation for the low stresses in zinc may be the extreme ductility of the metal at temperatures between 120°C. and 180°C., since this probably allows some stress relief owing to plastic yield as the metal cools through this temperature range.

The differences found in the steels are rather more striking in that steels of slightly different composition provide some of the highest and lowest stress values. In the case of the plain carbon steels, stress appears to vary inversely with carbon content, yet within the range of Swedish iron and eutectoid steel neither melting point nor coefficient of linear expansion vary to any great extent. The 18/8 and 13 per cent chromium steels are both classified as stainless, yet their stress values are widely different. In this case, however, the expansion coefficients are $19{\cdot}2\times10^{-6}$ and 13×10^{-6} respectively. Nevertheless, the difference is insufficient to account for the dissimilarity of stress values.

Interpretation of Results

It is suggested that phase changes which occur in the metals on cooling are largely responsible for the diverse results obtained. The 18/8 stainless steel, which has the highest stress value of the series, is essentially an austenitic steel and suffers no phase change when cooled from the plastic range. Swedish iron transforms from austenite to ferrite at about 850°C., and this involves a change in crystal lattice from face-centred cubic (F.C.C.) to body-centred cubic (B.C.C.), accompanied by a slight increase in volume. At this temperature the material is sufficiently plastic to accommodate the increased volume without setting up elastic strains. When the carbon content of straight carbon steel exceeds about 0·2 per cent, rapid cooling from high temperatures results in the formation of the transformation constituents—martensite and troostite, depending upon the concentration of carbon and rate of cooling.

The complete transformation from austenite to ferrite demands long-range movement of carbon atoms out of the austenite to form the carbide lattice (which can only take place slowly) and short-range movement of atoms from sites in the F.C.C. structure to sites in the B.C.C. structure. The transformation constituents formed on rapid cooling have an atomic distribution corresponding to a B.C.C. lattice, but because of carbon supersaturation the transformation is incomplete. In addition, the atoms in the constituents are less densely packed than in austenite or ferrite, and a considerable increase in volume occurs during the transformation. The mass increase in volume is related to the proportion of transformation constituents present which, in turn, is related to carbon contents of the steels. It is assumed that this increase in volume counteracts to some extent normal thermal contraction, since the changes occur at a stage in cooling at which elastic strains are increasing owing to thermal contraction. The 13 per cent chromium steel containing 0·25-0·3 per cent carbon would be expected to behave in much the same manner as the 0·9 per cent C straight carbon steel, for the chromium serves to promote the formation of martensite in the absence of carbon. Stress values are, indeed, similar, and it is considered that this adds support to the theory suggested.

Metallographic examination of the steel deposits has not given conclusive proof of the presence of the transition constituents—martensite and troostite. The sprayed carbon steels and Swedish iron have similar structures in that the deposits consist of random particles composed of exceedingly small acicular crystal grains which are dispersed amongst particles having structures that cannot be resolved by the optical microscope at magnifications up to 1,200 diameters. It is significant, however, that tempering of the deposits at 500°C. leads to the formation of sorbitic pearlite in the carbon steels and to fine equiaxed grains of ferrite in the Swedish iron.

The variations in structure of individual particles of the "as-sprayed" deposits are, no doubt, due to different cooling rates, which depend upon:—(1) The mass and heat content of the particles. (2) The temperature of the recipient particles. (3) The time interval from the deposition of one particular particle until its concealment by another. The factors leading to delayed cooling are thus: large particle size, high temperature of recipient particle, and short time of exposure to the air blast.

In conclusion, the investigations outlined above confirm that internal stresses of considerable magnitude are set up during metal spraying. Thermal contraction is mainly responsible, but in certain cases the effects are offset by volume changes associated with phase changes occurring in the solid state. Relative stress values of different metals and alloys may be readily determined, but precise evaluation of the internal stresses presents a complex problem necessitating further investigation.

Comparative stress values derived from the tests have some practical value. For instance, having established that a metal of known stress value gives rise to cracking, exfoliation, or failure of adhesion at a given deposit thickness, it would be useless to attempt to substitute a metal of higher stress value. Conversely, a much greater thickness of a metal with a lower internal stress value could be safely deposited in similar circumstances. It would appear that the permissible deposit thicknesses are in inverse proportion to internal stress values.

Acknowledgment is due to the directors of Metallisation Limited for permission to make known the contents of this Paper.

Nitrogen in Steel

CONSIDERABLE importance attaches to the role played by nitrogen in determining the properties of ferrous alloys, and reliable and accurate methods are, therefore, necessary for determining the content of this element in alloys.

The establishment of the reproducibility and accuracy of analytical methods to serve as routine or reference procedures for the many alloys now produced is a major undertaking. It was for this reason that the Nitrogen Group of the Steelmaking Division of the British Iron and Steel Research Association was set up some eight years ago. The Group's report, "The Determination of Nitrogen in Steel," has now been published as No. 62 of the Iron and Steel Institute's Special Reports.

The report, which comprises some 146 pages, of which there are 63 pages of tables, is available from the Association at 11 Park Lane, London, W.1, price 37s. 6d. (25s. 0d. to members of the Iron and Steel Institute).

Research Progress

Titanium Alloy Development

BY RECORDER

METALLURGICAL science has by no means yet reached the stage where confident predictions can be made about the effects of alloying additions on the behaviour of a relatively little-known metal. Consequently, the development of useful titanium alloys has depended upon *ad hoc* investigations aided more recently by gradually-acquired insight into the constitutional changes to be expected from the addition of various elements.

Although all-alpha alloys have been found to be resistant to high-temperature stressing, they are usually difficult to hot work. On the other hand, appreciable quantities of heavy alloying additions are required to form stable all-beta titanium alloys. There has been a tendency, therefore, in research on titanium-rich materials, to restrict the amounts of elements promoting beta formation and to obtain an alpha-beta structure in which the alpha phase is strengthened by the presence of an alpha-soluble element. Beta-stabilizing elements are particularly useful in conferring improved hot-workability, a property that is unfortunately adversely affected by aluminium—the most potent alpha-strengthener. For these reasons, several commercial alloys have been exploited containing up to 6-7 per cent aluminium and a few per cent vanadium, manganese, etc.

In the United States, hundreds of alloys have been tested, containing many combinations and permutations of alloying additions. The Armour Research Foundation, Chicago, has been one of the centres of such work, but there it appears to have been grasped at an early stage that the presence of aluminium is desirable in alloys that have to be stressed at temperatures of the order of 400°C. or so. Consequently, much of the Foundation's effort seems to have been spent on alloys containing 3-8 per cent aluminium with ternary and more complex additions.

Alloys Investigated

A large part of the development of the commercial titanium alloy containing 6 per cent aluminium-4 per cent vanadium was carried out at the Foundation and more recently, workers there have shown that alloys containing up to 7 per cent aluminium and about 3 per cent molybdenum have interesting properties at room and elevated temperatures. This has naturally led to a search for improved materials based on the titanium-aluminium-molybdenum composition but bearing also other additions, both alpha-soluble, e.g. tin, or beta-soluble, e.g. vanadium. In the present work,[1] the following alloys were tried: 6 Al-3 Mo-2 or 4 Be, 6 Al-3 Mo-4 Sn or Zr, 6 Al-3 Mo-2 Sn-2 Zr, 6 Al-2 Mo-1 Cr or 1 Mn or 1 V, and 6 Al-1 Mo-1 Mn-1 Cr or 1 V. It will be seen that where beta-stabilizers were added to the basic 6 Al-3 Mo alloy, the molybdenum content was reduced by the same amount (in per cent). There would thus appear to be an inherent assumption about the equivalence of the beta-stabilizers employed, and this must be arbitrary. Presumably the underlying objective was to avoid the undue lowering of the alpha+beta-beta boundary that might have occurred with too great a preponderance of beta-stabilizing additions.

Melting and Heat-Treatment

Six-pound ingots of the above materials were double-melted, using 120 B.H.N. sponge. No details about further processing are given by the authors, F. A. Crossley and W. F. Carew, except the statement that forging was carried out in the alpha+beta region starting at a fixed temperature interval below the estimated position of the all-beta boundary of each alloy. Specimens 1·25 in × 0·252 in. dia. were used for subsequent testing after being given a heat-treatment [1,470°F. (799°C.) for 6-hr.—air cool—1,000°F. (538°C.) for 24 hr.—air cool], known to stabilize titanium-aluminium-molybdenum materials at a fairly high strength level. There is, of course, no guarantee that this was the optimum heat-treatment for any of the complex alloys, and this choice underlines the difficulties that arise when a large number of materials of varying characteristics have to be examined. It was, in fact, found that after such processing eight of the eleven alloys showed Widmanstätten structures, whilst the remainder (containing in addition to aluminium and molybdenum either 2 Be, 4 Be or 1 Mn) had an equiaxial type of structure. The 6 Al-3 Mo-4 Be alloys also showed a third phase in the form of small particles believed to be titanium-beryllium.

Resulting Properties

Tensile tests were carried out at room temperature, 600°F. (316°C.), 800°F. (427°C.) and 1,000°F. (538°C.), and Crossley and Carew treat the results as two groups. In the first, the alloying additions (tin, zirconium, beryllium) tend to strengthen the alpha phase, and all these materials gave a higher ultimate strength at all the test temperatures than the basis 6 Al-3 Mo alloy. Owing to the method by which the authors present their data, it is not easy to obtain exact values for each material from the Paper: the figures given hereafter are, therefore, approximate only. The basis alloy had an ultimate strength of about 145,000 lb/in^2 at room temperature and 85,000 lb/in^2 at 1,000°F. The strongest alloy at room temperature was that containing 4 Be—165,000 lb/in^2, which was also superior to the others at 600° and 800°F. At 1,000°F., however, the 4 Sn and 2 Sn-2 Zr materials gave higher strengths than the 4 Be alloy, both having an ultimate tensile of about 105,000 lb/in^2. The tin-bearing alloys were also more ductile at all temperatures than the 6 Al-3 Mo-4 Be alloy. It is interesting that although the 4 Sn addition gave greater strengthening than the 4 Zr addition, the combination of 2 Sn-2 Zr appeared equivalent in this respect to 4 Sn.

Most of the second group of alloys (containing Mn, Cr, V) gave better properties than the basis material, though the 6 Al-2 Mo-1 V alloy was less strong than 6 Al-3 Mo at room temperature, 600°, and 1,000°F., and, in addition, the 6 Al-2 Mo-1 Cr material was slightly weaker than 6 Al-3 Mo at 600°F. At room temperature and 1,000°F. the strongest alloy was 6 Al-1 Mo-1 Mn-1 V (giving ultimate strengths of 157,000 and 90,000 lb/in^2 respectively) though this material was inferior at 600° and 800°F. to that containing 6 Al-2 Mo-1 Mn. The authors point out that this latter alloy was one of the exceptions, having an equiaxial structure, and this might account for the change in relative position at different temperatures of the 2 Mo-1 Mn and 1 Mo-1 Mn-1 V materials.

Stress rupture tests at 1,000°F. extending up to 1,000 hr. showed that the alpha-strengthening additions confirmed improved resistance to stress under such conditions. The increases in strength varied from alloy to alloy and did not exactly follow the pattern obtained with the short-time tensile tests at 1,000°F. In creep tests at 800°F. most of the complex alloys gave a lower secondary creep rate at a given stress than the basis material, but at 1,000°F., only the materials containing tin additions were definitely superior to 6 Al-3 Mo for stresses giving creep rates of less than 10^{-4} in/in/hr.

The behaviour of the remaining alloys containing beta-soluble elements in stress rupture and creep tests was,

(*Continued on page* 516)

TECHNIQUE USED IN WAVEGUIDE MANUFACTURE

Dip Brazing Magnesium

DIP brazing has been successfully adapted to the fabrication of magnesium waveguide systems by the Dalmo Victor Co., of California. Magnesium dip brazing is somewhat similar to aluminium dip brazing in that parent metal-base filler alloys as well as chloride-base fluxes are used. In fusion welding, the parent metal parts must be melted in order to join them together; the net result of this condition is that shrinkage and warpage problems occur. So far two parent material alloys of magnesium have been successfully brazed, M1A alloy (magnesium-1·5 manganese) and A X31B (FSI) alloy (3 per cent aluminium-1·0 per cent zinc-0·45 per cent manganese). The most satisfactory brazing filler alloy to date has been found to be A X125. Dow brazing flux No. 452 has given the best results with this filler alloy.

The present magnesium dip brazing process at Dalmo Victor consists of the following steps: deburr, clean, assembly, preheat, dip braze, and remove flux.

The success of a brazed joint depends largely upon the mechanics of capillary flow and gravity. Parts must be free from burrs because they have a tendency to restrict the flow, and an unsuccessful braze will, therefore, result. The molten filler alloy will flow quite easily along a joint, but will not flow evenly across a burred-up area.

Parent metal parts and filler metal are cleaned by degreasing, lightly sanding with alozite cloth or electrolytic caustic dip, followed by a hot water rinse, and air blast drying.

Filler metal shims and wires can be formed and/or stamped out once the proper size and shape have been determined. Filler metal (AX125), due to its somewhat brittle nature, does present some difficulty in forming, but with proper handling, simple forming operations can be accomplished. The parts are assembled in a brazing fixture (if one is needed) with the filler metal in place.

Proper clearance to allow for filler metal flow ranges from 0·004 in. to 0·006 in. per side, depending on the size and length of the braze joint required. Staking, self-positioning, spring-loaded fixtures, and tack welding are some of the methods of pre-braze assembly that are used. It is important to note that MIA alloy welding rod should be used for tack welding.

The assembly is preheated in an oven at a temperature of 850°F. This operation accomplishes two things: (1) the evaporation of moisture from the assembly, and (2) the reduction of heat loss of the flux bath.

The assembly is removed from the preheat oven and immediately immersed in the flux bath. Immersion time varies from ½ min. to 3 min., depending upon the mass of the assembly. Immersion time should not be any longer than is necessary to accomplish complete filler metal flow, because of the alloying of the filler metal with the parent metal. This will result in a washing out or undercutting around the braze joint.

The assembly is removed from the flux bath and is allowed to cool to approximately 600°F., and then plunged into boiling water to remove the bulk of frozen flux. The assembly is then given a 1 min. dip in Dow No. 1, followed by a 2 hr. boil in a 5 per cent sodium dichromate solution.

After these steps have been completed, the assembly is ready for finish machining and/or protective coating.

Four factors must be considered in the design of a magnesium dip brazing fixture:—

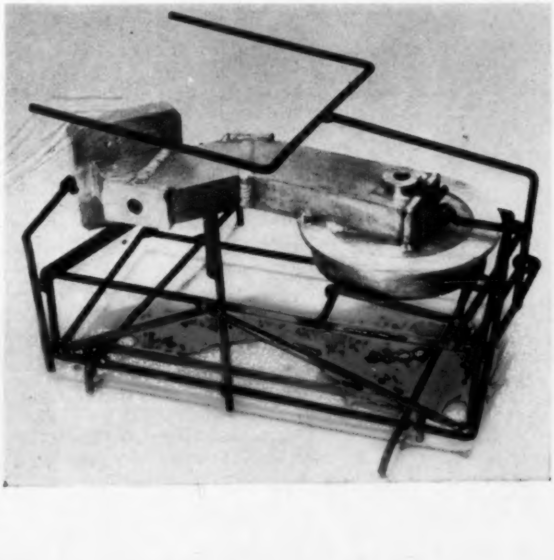
Mass. Fixtures, if needed, should be kept to a minimum size and weight consistent with the parts to be positioned. Excess mass contributes to reduction of flux bath temperature and increases the amount of flux drag-out, both of which are undesirable.

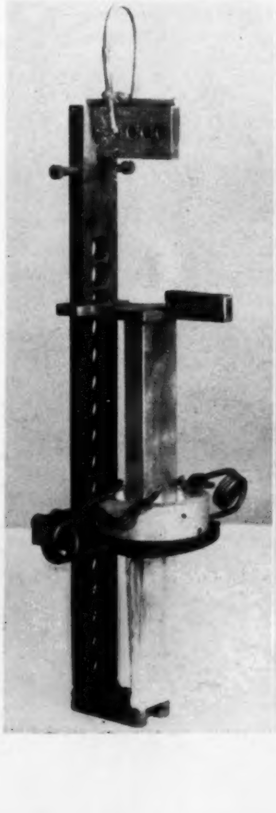
Flux Drainage. This calls for simple fixture design to facilitate fast, complete drainage of the molten flux from the assembly and fixture. Flux entrapment can be a most serious problem if blind holes and closed cavities are not avoided. A free flow of water through

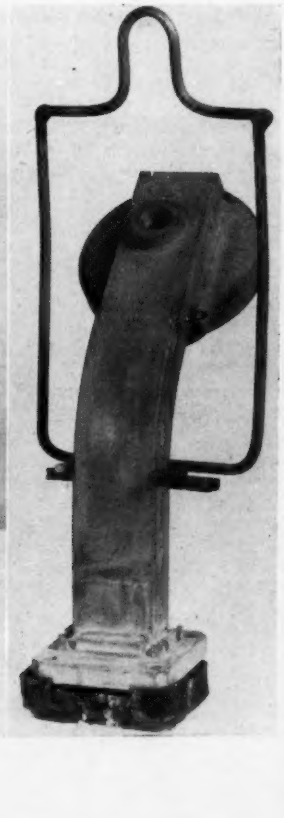
Right: Fig. 2—Arrangement for brazing a heavy boss in the centre of a waveguide tube

Extreme right: Fig. 3—A waveguide in which the flange, button and body have been brazed on to the tube

Below: Fig. 1—Waveguide in fixture, showing a combination of welding and brazing







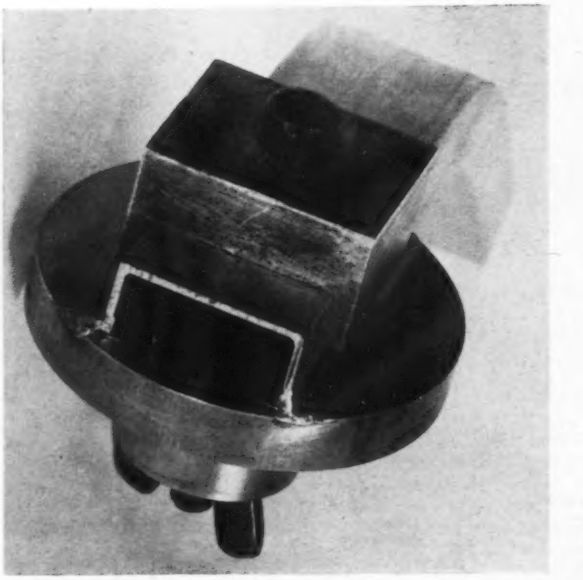


Fig. 4—Tack welding of a rotary joint body to a tube with brazing shims in place

passages and across joints is most essential.

Corrosive Action. The flux bath contains, among other things, several salts which, under certain conditions, are highly corrosive to most metals. The dip brazing fixtures should be made of stainless steel or high chromium steel so as to resist this corrosive action of the flux bath.

Thermal Expansion. The difference between the expansion of the magnesium parts and the steel fixtures must be given careful consideration at the design level. The fixture must maintain proper positioning of the parts to be brazed and, at the same time, allow for the expansion differential during the preheat and brazing cycles.

Magnesium dip brazed joints so far produced have demonstrated a sufficient degree of structural integrity for waveguide systems. Preliminary tests have indicated that a shear strength of from 12,000 to 14,000 lb/in^2 for a lap joint brazement may be expected. A great number of brazements of various configurations have been subjected to an internal pressure of 35 lb/in^2. The percentage of leakers has been something less than 0·25 per cent.

An X-ray examination of typical brazements shows no cracks, and very little or no porosity or voids. With careful design, the slight porosity or voids, as the case may be, should present no problems. Due to the elevated temperature and time element involved in the dip brazing cycle, a reduction of strength of the parent material is to be expected. For example, a X31B waveguide tubing before the brazing cycle has an ultimate strength of 34,700 lb/in^2, but after the brazing cycle this value is reduced to 31,300 lb/in^2. Standard 50 hr. salt spray tests of magnesium dip brazed specimens have been conducted upon several occasions, using a typical production waveguide weldment as a control specimen. Brazements which have had the same protective coating as the weldment survive these tests as well as, or better than, the weldment control specimen.

Men and Metals

At this month's meeting of the Institute of Physics, the following were elected as Fellows of the Institute:— **A. S. Douglas, J. Franks, K. D. Froome, D. E. Godfrey, E. O. Hall, G. W. Hamstead, H. K. Henisch, S. C. Jain, W. O. Lock, S. G. G. Macdonald, G. W. A. Morris, B. G. Owen, K. I. Roulston, A. H. Ward, P. E. Watson,** and **R. W. H. Wright.** In addition, 47 associates, 43 graduates, 74 students and four subscribers were also elected.

Now superintendent of steel production of the Steel Division in the Steel Company of Wales Limited, **Dr. A. J. Kesterton** is to take up the appointment of managing director of Davy British Oxygen Limited early next year.

At the Autumn General Meeting of the Iron and Steel Institute, recently held, it was announced that **Mr. William Barr,** O.B.E., honorary treasurer of the Institute since 1953, had been nominated by the Council for election as President of the Institute for the 1959-60 session. He will take office at the Spring General Meeting in May next. Mr. Barr is a director of Colvilles Limited, of which company he became chief metallurgist in 1936. He was appointed a director of the Fullwood Foundry Company Limited in 1945, an executive director of Colvilles two years later, and a full director in 1954.

With 29 years' service with the company to his credit, **Mr. R. D. Turner,** A.M.I.Mech.E., A.M.I.Prod.E., has now been appointed a director of

Metal Castings Limited. Mr. Turner was sales manager of the company from 1954 to 1958, and was appointed general manager on October 1 this year.

In succession to **Mr. T. S. Aikman,** who has recently retired, **Mr. R. H. Mardell** has been appointed London area sales manager for General Refractories Limited.

Chairman of Head Wrightson and Company Limited, **Mr. Richard Miles** left England last week by air for South Africa to visit the company at Johannesburg and its associate company, Wright, Soag and Head Wrightson (Pty.) Limited, and to make a short stay in the Federation.

Until recently chief engineer of the Consolidated Pneumatic Tool Company at Fraserburgh, **Mr. W. Forbes Ritchie** has been appointed manager of factory operations. Mr. Ritchie joined the company in 1937 as an apprentice, and spent two years in the machine shops. In 1939 his training continued in the drawing office until joining the Royal Air Force in 1942. In July, 1946, he returned to the drawing office until joining a newly-formed engineering department at Fraserburgh. He was placed in charge of this department in 1956, and a year later was appointed the company's chief engineer.

To succeed **Dr. H. M. Finniston,** who recently took up an appointment with the Nuclear Power Plant Company, **Mr. L. Grainger,** B.Sc., A.I.M., has been appointed head of the metallurgy division in the United Kingdom Atomic Energy Authority's research group at Harwell. Mr. Grainger joined A.E.A. in 1951, and in 1955 moved to Risley as chief metallurgist in the Research and Development branch.

HIGHER SPEEDS — HEAVIER COILS — AUTOMATIC CLEANING

Developments in Strip Production Machines

As in most other industries, changing patterns of production in strip rolling have led to the development of faster machines, able to handle a greater size range of material. To keep abreast of the demand for such machines often necessitates an approach to design problems that departs from the conventional. Such an approach is one of the aims of Auxiliary Rolling Machinery Ltd., of Tipton, Staffs., and in what measure it is achieved may be judged from some recent developments in their equipment for handling and slitting heavy coils. Before attempting to describe the equipment, the background of change in the industry, as it applies to strip coiling and slitting, should, perhaps, be sketched in, and, as everywhere, the main feature is the drive for greater production. This may again be broken down into three aspects:—faster and more continuous working; more productive usage of skilled and semi-skilled labour; greater accuracy and, hence, less waste.

Considering the first of these aspects of the drive for faster production of strip, the most prominent feature has been the increase in slitting speeds. Two years ago, it was normal for the type of machine that A.R.M. manufacture for the coil to be slit at speeds up to 150 ft/min. To-day slitters are being made with a multi-speed range up to 700 ft/min., and even this range may have to be extended. As a corollary to this increased speed, there has arisen the demand for larger coils, to permit more continuous working. Coils of up to 4,000 lb. in the non-ferrous trade and 5 tons in the ferrous trades are now common, thus sturdier and more versatile coilers and uncoilers have been demanded.

Effective use of the more skilled operatives involves all purely manual operations to be carried out by a labourer; it also means that changeover time has to be reduced to a minimum. Thus, work such as coil banding is better done away from the machines, and rapid cutter changes are desirable.

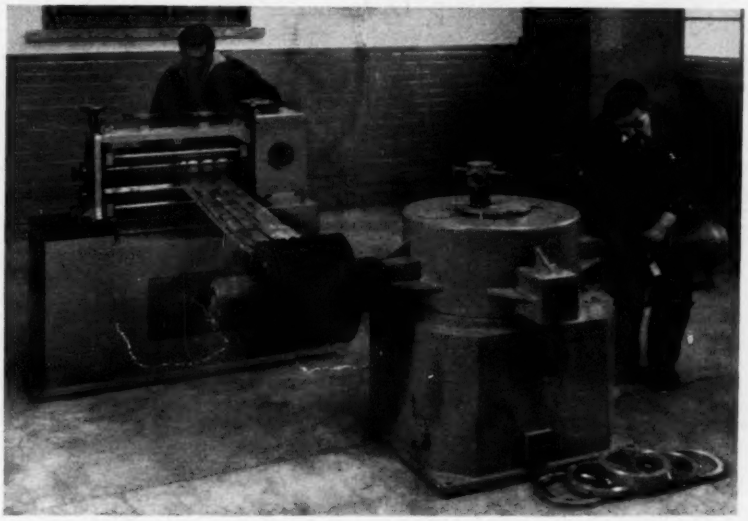
The desire for greater accuracy and reduction of waste is reflected in a tendency for some firms to avoid stocking a wide variety of widths and gauges by installing a slitting line and even, in some cases a 2-high skin pass rolling mill. This enables them to stock, say, 28 in. wide material, slit to the required width, and break down the gauge to that desired with greater accuracy than is frequently obtainable and with a considerable saving in cost.

Equipment at present being built by A.R.M. is designed to meet the above requirements, and includes coil openers, slitters, uncoilers, coil carrying cars, 2-high and 4-high strip mills, straighteners, continuous tube mills, and continuous cleaning lines.

Coil Handling

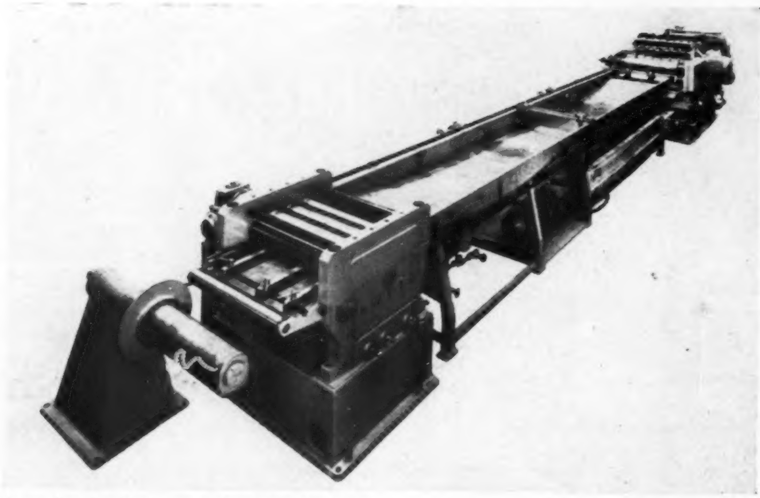
Uncoilers, for instance, are now being built to take 28 in. wide non-ferrous material in coils of up to 4,000 lb. This increase in size has necessitated larger drum sizes. These drums can be hydraulically expanded from 18 in. to 21 in. to grip the inside of the coil. Lateral movement is also provided so that the coil can be centralized with the slitting machine head, a 2 in. movement either way being possible. In order to provide back tension, an air brake is fitted, with a by-pass for rapid braking.

On one coiler, drums of three sizes are used: 8 in., 12 in., and 18 in. dia.



Slitting machine and coiler of A.R.M. design as produced two years ago

Slitting equipment of current design. In the foreground is the uncoiler, at centre right is a slitter and behind that a coiler. On the left is a slitter with the head swung aside for cutter changing



One of the A.R.M. automatic strip cleaning lines

This range of drums caters for the majority of customers' individual demands. They are driven by a two-speed motor through a change speed gearbox giving a wide speed range of 150-650 ft/min. A friction clutch, used for normal driven-type slitting, may be disengaged so that the machine automatically becomes a pull-through coiler.

The drums are of the cone type, and can be quickly dismounted for changing. A hydraulic coil push-off is incorporated, the hydraulic system being a built-in separate motorized unit.

To facilitate the handling of coil, and to permit banding being done away from the machine, a coil-carrying car of unusual design has been developed. Normally running on rails, this has separator plates which are hydraulically raised to lift the coil off the coiler. The separator plates are spaced a short distance from each other, allowing the band to be passed around the coils while they are on the car. The separator plates also serve to control the tail end of the coils as coiling is completed — once more relieving the operator of an awkward task.

Slitting Machines

Rapid changeover is the feature of the slitters, many modifications having been introduced to facilitate more continuous production. One of these is a completely interchangeable head, secured by four bolts. This permits a complete cutter head to be fitted up away from the slitting line as a tool-room process for any particular width of coil to be slit into any desired combination of widths, at the same time as the slitting line is in full production. By removing the four bolts, lifting off the head from the slitter, and placing the alternative head in its place, a complete changeover can be effected in a few minutes.

Complete ease of cutter changing has been aimed at with the latest machines. This has been facilitated by arranging the guide table and tail-stock as hinged units. It is, therefore, only necessary to release one bolt securing the guide table, swing the table sideways so that it is clear of the head, and release the tailstock which swings downward to expose the ends of the cutter spindles. The cutters and spacers can then be withdrawn and changed.

A further feature of these slitters is that adjustment is carried out via the bottom spindle, thus eliminating back-lash in the chocks and making slitting of thinner material easier and more positive.

Apart from these coiling and slitting machines, the company have improved the design of their continuous strip cleaning lines, which now incorporate facilities for brushing, drying, and for soaps.

Tube Mills

A further development has occurred in the design of continuous tube mills for the production of welded tube from ¾ in. to 4 in. diameter. In these mills the strip passes through an edge trimmer, then via an accumulator (which takes up excess strip not passing through while the coil is being butt-welded to a following coil) to a skin pass mill. This mill serves the purpose of sizing or tempering, and breaks strip down approximately one gauge (depending on original gauge). The strip then passes through the tube mill, where it is formed, followed by welding.

A feature of the welding equipment is the development of a transformer operating at 150 cycles/sec., thus giving a performance comparable with equipment made in the U.S.A. After welding, the joint is cleared up, the tube passes through a sizing mill, and thence to a flying saw where it is cut to length.

There is no break in the operations listed, and the practice of butt-welding one coil on to the next enables fast, continuous production to be maintained, speeds of 150 ft/min. obtaining for ferrous materials.

Research Progress—continued from page 512

however, disappointing. All were less resistant under slow straining at 800° and 1,000°F. than the basis material, and it is interesting that although 6 Al-2 Mo-1 Mn and 6 Al-1 Mo-1 Mn-1 V were the strongest materials in short-time tests at elevated temperature, they were among the least resistant to creep conditions. The 6 Al-2 Mo-1 V alloy, on the other hand, which gave the worst short-time results, was the most resistant to creep at 1,000°F. of the complex materials in this group.

Tensile tests at room temperature of creep specimens strained at 800° or 1,000°F. were carried out to check the "stability" of the alloys. The basis material gave essentially the same tensile properties before and after exposure as did the alloys containing 4 Be and 4 Zr. Both tin-bearing alloys showed reduced ductility after elevated temperature straining, however, particularly unfortunate here as these were the only materials giving creep properties superior to the basis material. Finally, in the second group of alloys, 6 Al-2 Mo-1 Mn and 6 Al-2 Mo-1V appeared to be stable, the others having reduced ductility after creep straining.

Despite the disappointing nature of the results of this work, it would be rash to suggest that none of the alloys examined could not be used as a superior substitute for the 6 Al-3 Mo basis material. The stability of the tin-bearing alloys might be improved by using a different heat-treatment than the one selected by Crossley and Carew, and the room temperature strengths, particularly of the alloys containing two or more beta-soluble elements, might also be considerably increased by this means.

Reference

1 F. A. Crossley and W. F. Carew; *Trans. Met. Soc. A.I.M.E.*, 1958, **212** (5), 630.

Obituary

Mr. R. T. Rolfe

We regret to record the death of Mr. Robert T. Rolfe, O.B.E., F.R.I.C., F.I.M., chief metallurgist of W. H. Allen and Sons Ltd., Bedford, until his retirement in 1955. The author of a number of books and Papers on foundry practice and metallurgy, for one of which he received the Constantine Gold Medal in 1929, he was awarded the O.B.E. in 1952. He was a member of the Institute of Metals, the Iron and Steel Institute, and the American Society for Testing Materials.

New Plant & Equipment

Tensile Testing

ADDITIONAL to the range of smaller Olsen "L" type hydraulic testing machines, a 400,000 lb. capacity machine has recently been built by Edward G. Herbert Ltd., Atlas Works, Chapel Street, Levenshulme, Manchester. There are now five capacity ranges:—60,000 lb., 120,000 lb., 200,000 lb., 300,000 lb., and 400,000 lb., the basic design being similar in each case.

The machine is designed so that the complete hydraulic and mechanical systems are enclosed in a welded frame which is built as a compact rugged unit of modern contour, low weight and low cost.

Tensile and compression tests are covered by the standard equipment of flat grips, vee grips, and a compression plate. A complete range of accessory testing tools is manufactured, and these cover, for example, transverse, shear and bend tests.

Loads on this machine are indicated on two 16 in. diameter precision type hydraulic gauges mounted on the instrument panel above the hydraulic and electrical controls. These gauges are provided with maximum pointers.

The pressure which actuates these gauges is developed in a ground and lapped piston and cylinder, which are designed to operate without packings of any kind. A slight film of oil separates these surfaces at all times. With this design, friction is held to an absolute minimum and the load is weighed within close limits, and the machine is built to Grade "A" accuracy in accordance with British Standards 1610 Part 1, 1958.

The load application is accomplished by a hydraulic piston and cylinder located in the base of the machine. Thus the centre of gravity is extremely low. This feature eliminates the necessity for any rollers or guides, and reduces the shock of breaking specimens.

The load is applied to the specimen by motion of the piston. The hydraulic pressure is developed from a direct-connected motor-driven gear pump. This pump, in combination with the Olsen automatic valve, provides uniform rates of load application. A safety valve and electric limit switches protect the gauges from overload.

Normally, a range of testing speeds from 0 to 2 in/min. is obtainable in stepless intervals.

Strip Reeling

A RANGE of reels for coiled strip up to 36 in. wide and 5,000 lb. in weight has been introduced by Press Equipment Ltd., of Hunters Vale, Birmingham, 19.

Typical of these machines, the one shown in the accompanying illustration is a non-motorized machine with a capacity of 26 in × 2,500 lb. It incorporates a detector arm which applies a particularly efficient pneumatic disc brake to check over-run. Removable end clamps are fitted if the coil is susceptible to lateral movement, and to guide coils of reduced width.

The segmented mandrel is self-centring, and adjustable in diameter by a detachable handle through a lead screw and nut, sliding sleeve and links. Alternative link positions allow increased range of adjustment. Extensions of the mandrel segments pass through guide slots in the faceplate (which can be in the form of four radial arms, if preferred, to facilitate overhead crane and sling loading), and enable roller bearings to be provided on either side of the faceplate for support and easy adjustment of the mandrel. The centre shaft is of ample capacity, machined to a high degree of accuracy, and revolves upon heavy duty, self-aligning bearings. Grease gun lubrication is provided throughout.

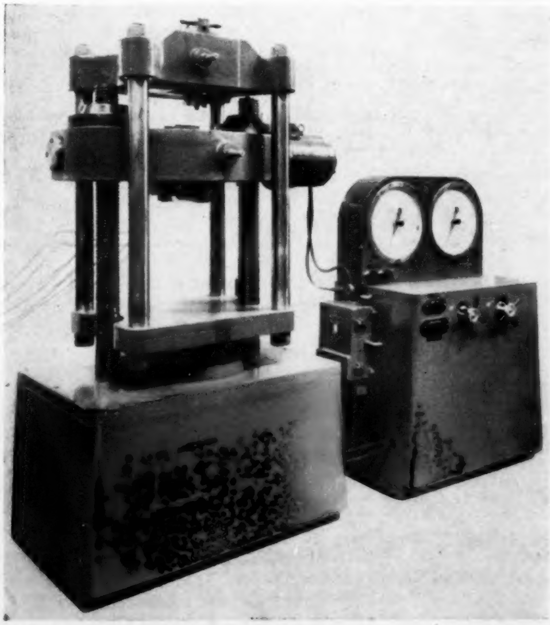
Motorized reels incorporate an automatic infinitely variable speed control to coincide the decoiling speed of the strip exactly with the rate of consumption, and are also available for rewinding.

Optional extras to meet specific requirements are hydraulically operated elevating gear, mobility with jack, castor and steering gear, or track mounting on rails.

Metal Cleaning

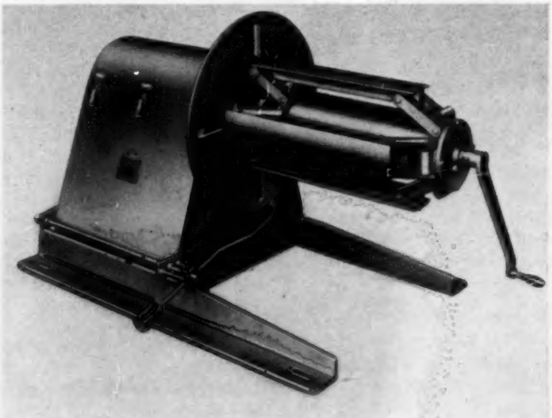
A SINGLE-CHAMBER machine which uses the spray method, and is suitable for pickling, degreasing and phosphating of all metal components has been introduced to this country by I.F.A. Engineering Co. Ltd., 13-17 Rathbone Street, London, W.1.

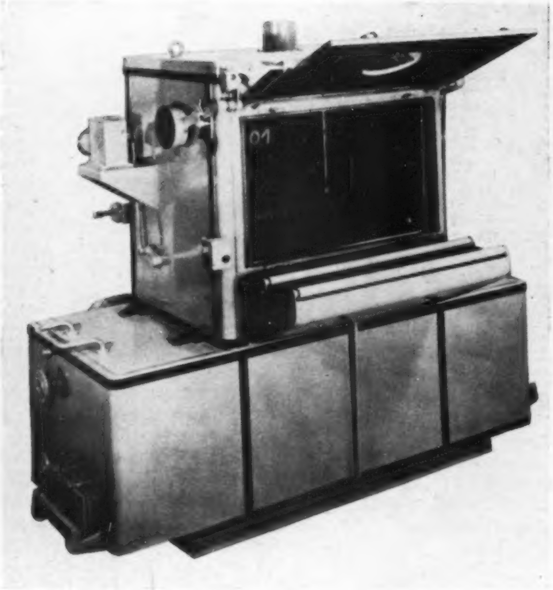
In this machine, the Wache single-chamber metal washing machine, the wire basket containing the work to be treated is inserted into the spray chamber and the door closed by hand. The action of closing the door starts the stop clock, and the pre-set working sequence is commenced. First, the degreasing or treatment pump and rocking gear for oscillating the



Left: The Olsen 400,000 lb. capacity L-type tensile testing machine

Below: The 26 in. × 2,500 lb. manually-operated strip reel





Left: The Wache single chamber metal washing machine

Right: The Elcotector for measuring thickness of foils and coatings

basket are switched on. At the end of a set time, this pump is switched off and the tipping plate positioned to return the liquid to its specific tank. This is followed by the starting of the next pump, and so the operation is repeated twice more.

On completion of all these operations, a signal light is switched on automatically to indicate to the operator that the treatment of the work is finished and that it can now be removed from the spray chamber.

Two or three thermometers, each with a range of 0-120°C., are fitted to the machine to check and control the temperatures of both the treatment solution and the hot water for the rinse.

Three different sizes are available: No. 1—height 24 in., length 36 in., width 24 in.; treatment solution capacity, 132 gal. No. 2—height 24 in., length 48 in., width 24 in.; treatment solution capacity, approx. 165 gal. No. 3—height 24 in., length 48 in., width 32 in.; treatment solution capacity approx. 185 gal.

Measuring Foil

PRIMARILY intended for all types of coating measurements on components, the "Elcotector," a product of East Lancashire Chemical Co. Ltd., Fairfield, Manchester, is also capable of measuring the thickness of most metallic and non-metallic foils, both in the static and moving state, thus it can be applied to the production run to give continuous readings of thickness as material is produced.

The device makes use of the fact that the electrical characteristics of a coil are influenced in proportion to its proximity to a metal surface. Under suitable conditions, a meter is capable of translating these changes in the coil into measurements of non-metallic coating on metal. This coil is also influenced by the type and structure of the metal, i.e. these changes can be translated into metal film thickness, metal hardness and like measurements.

The coil in the case of the Elcotector is situated in the head of the probe, which is presented to the surface under test. Two types of probe are available—one in the form of a short pencil for general purposes, the other with a short head and angular extension to enable its use in narrow confined spaces, these two being used for hand checking purposes only. For continuous strip measurement, special probes can be produced capable of accommodation on any specific machine. They can be housed in P.T.F.E. frictionless material, and so lightly balanced as not to affect even the most delicate material. Hollow cup or pot coils are provided for repetitive hardness measurement of such small tools as drills, plug gauges, taps, steel balls, etc.

Readers' Digest

ELECTROPLATING

"Technical Proceedings of the 45th Annual Convention." *Published by American Electroplaters' Society, 443-445 Broad Street, Newark, New Jersey, U.S.A. Pp.* 184.

IN this volume of proceedings, the technical matter is divided into seven sections, corresponding to the sessions held at the Convention, which took place in Cincinnati, Ohio, in May of this year. The sessions each dealt with a specific aspect of electroplating as follows: Surface Preparation, Waste Treatment and Disposal, Electroplating Practice (two sessions), Specialized Finishes for Aircraft Components, Developments in Finishes and Controls, Practical Plating Problems.

It will be seen from the foregoing that a considerable field is covered, and the range of Papers includes a similar selection to that of previous years. There is the customary collection of Papers dealing with investigations into such aspects of deposits as the influence of the metallurgy of the basis metal, factors affecting structure of deposits, pitting in thick chromium deposits, etc. There are also several Papers dealing with particular processes which involve proprietary products, and there are the review Papers that present a correlation of advances in the industry.

Comparisons, though odious, may be instructive and a glance through a similar publication from one or another European country might provide some food for thought, and serve to emphasize the varying patterns that technical societies follow in different countries. In this context the "non-technical forepart" of the present volume is of interest; it reveals a much greater concern with the personalities of the industry than would commonly be shown by similar societies on this side of the Atlantic. There are also fairly detailed accounts of the meetings, with considerable lists of committee members, delegates, and so on.

It is frequently the case, in all symposia, that the comments or questions arising in discussion illuminate aspects of the problem under survey in quite a different way to that shown by the authors, and it should, therefore, be mentioned that the discussion at each of the sessions is also included.

Finally, there is a report of a panel discussion on practical plating problems, in which questions and answers are given—a section of the book that will be of particular interest to the man on the shop floor, where often the procedures carried out in laboratories and research establishments cannot readily be adapted to his needs.

Industrial News *Home and Overseas*

Abrasive Belts

A new rotary dressing tool for cleaning abrasive belts, which is being marketed by **Finishing Aids and Tools,** is designed to prolong the working life of belts and reduce the number of changes. The tool is well designed, very simple in construction, and comprises an easily-removed triple wire rotary brush, 1 in. wide, mounted in a cast iron casing. The brush is force-fitted on to a special hardened steel pin, which fits into steel bearings inside the case.

The casing itself, which is semi-cylindrical, 2¼ in. wide, provides adequate protection for the operator's hands and reduces the danger from flying particles. One side of the casing is detachable for replacement of brushes when necessary. This plate is held in place by a nut. The tool is fitted with a stout handle, 9¾ in. long, with a ferrule at the forward end where it joins the casing.

A Fellowship Trust

Founded for the purpose of improving and increasing the interchange of ideas between scientists in the United Kingdom and on the Continent, the **CIBA Fellowship Trust** will award several Fellowships for tenure during the academic year 1959-1960 at Continental universities or institutions, for research in chemistry, physics, or some other allied scientific subject.

These awards will be made to graduates of universities situated in the U.K. or to members of those universities graduating this year. It is anticipated that some Fellowships will be awarded to recent graduates, and others to candidates who have already taken their Ph.D. or who have already spent some time in industry. The basic award for Fellows who have already undergone training in research and wish to continue post-doctorate studies, will be £800 per annum, plus allowances, including cost-of-living and children's allowance.

For candidates who have obtained a First degree in science and wish to undergo training in research, the basic award will be £500 per annum, plus similar allowances. Full details of these Fellowship awards may be obtained from the Secretary of the CIBA Fellowship Trust, CIBA (A.R.L.) Limited, Duxford, Cambridge.

Useful Publication

A technical publication entitled "Chemistry of Cyanidation" is being offered by Cyanamid International. This publication deals with the chemistry of complex gold and precious metal ores. It provides an analysis of the problems inherent in cyanidation of ores containing copper, zinc, nickel, arsenic and antimony, carbonaceous materials, sulphide minerals and reagents used for the flotation process.

A copy of this book may be obtained on request to the General Chemicals Division, **Cyanamid of Great Britain Ltd.**, Bush House, Aldwych, London, W.C.2.

Noble Metal Thermocouples

A second edition of "Noble Metal Thermocouples," by H. E. Bennett, F.I.M., has been published this month by **Johnson, Matthey and Co. Limited**. The contents give a comprehensive survey of the development of noble metal thermocouples, their applications and methods of calibration. The properties of the platinum group metals and their alloys in relation to the problem of temperature measurement are discussed, and information is given on the principal causes of deterioration of thermocouples.

Two new sections have been added to the book. The first of these is "Temperature Measurement in Glass Manufacture." Radiation methods of temperature measurement are employed, but these are not as suitable as the thermocouple for accurate temperature determination in the depth of the melt. Moreover, by employing a well protected platinum:rhodium-platinum thermocouple the temperature at chosen points of the melt can be continuously recorded and automatic temperature control becomes possible.

The second new section is "Temperature Measurement in the Foundry." This describes the quick immersion technique, which, by employing a suitably sheathed platinum:rhodium-platinum couple and an automatic indicating-recording instrument, provides a rapid, accurate and reliable method of determination of the temperature of molten metal. The book is available free on application to the Publicity Department at the company's head office at 73-83 Hatton Garden, London, E.C.1.

Boron Trichloride

An agreement was announced in the United States last week between Dow Chemical Company and United States Borax Research Corporation, a wholly-owned subsidiary of United States Borax and Chemical Corporation (the operating company in the U.S.A. of Borax (Holdings) Ltd.), to engage in a joint venture to perfect an economic process for the manufacture of boron trichloride. Boron trichloride, derived from boron and chlorine, is a highly reactive intermediate from which many of the newer boron compounds can be made. Dow and U.S. Borax have both been engaged for some time independently on research in this field.

Enquiry from S. Rhodesia

It has been reported to the Board of Trade by the U.K. Trade Commissioner at Bulawayo, that Mr. L. H. Thompson, the managing director of Arrow Bronze Foundry (Pvt.) Ltd., of P.O. Box 8252, Belmont, Bulawayo, Southern Rhodesia, has told the Commissioner that his company is interested in the possibilities of making bronze or aluminium castings for, or under licence to, United Kingdom firms. He feels that there may be British firms exporting castings of various types to the Federation who might be interested in having them made for them locally. He found it difficult to be specific about the sort of thing he had in mind, but mentioned items such as pump impellers and various cast items for railway use, and possibly some items of builders' hardware.

The Arrow Bronze Foundry was set up in Bulawayo some eight months ago. The company is associated with Standard Brass, Iron and Steel Foundries Limited, of Benoni, South Africa. The Bulawayo foundry is equipped for production of castings by both the ordinary "static" methods and by the centrifugal spinning method, and claims to be the only foundry in the Federation equipped for the latter. It is currently producing bronze sticks and bushes and various other castings, such as aluminium tile moulds, for Rhodesian industries. The present capacity of the foundry is about 70 tons a month in total, with a capacity for individual castings up to about 400 lb. These could both be increased without much difficulty.

Manufacturers interested in this enquiry should write direct to the Bulawayo firm. It would be appreciated if, at the same time, they would notify the United Kingdom Trade Commissioner, African Life Building, Main Street, P.O. Box 1514, Bulawayo, that they have done so.

British Trade Fair

It has been announced by **The Engineering Centre, Birmingham,** that its space allocation at the British Trade Fair, Lisbon, May 29 to June 14 next, has now been confirmed, and that the Centre's group display will occupy approximately 800 ft^2 on the ground floor of the main exhibition hall.

This group display will provide room for approximately 25 firms, and those interested are invited to contact the Centre without delay. Rental figures, it is stated, will probably be in the region of £3 per ft^2, including shell scheme, organization and staffing, although the figure has not yet been finally computed.

Engineering Display in Canada

Manufacturers in this country, and in the fields enumerated, should be interested in the group display to be made at an Exhibition in Canada by **The Engineering Centre**. The fields covered include welding equipment, small tools, machine tools, instruments, hydraulic control, drafting equipment, furnaces, and heat treating, paint spraying, foundry equipment, and electric plant.

This exhibition is to be held in the Industry Building at the National Industrial Production Show of Canada, in Toronto, from May 4 to 8 next year.

Scientific Instruments

Readers are reminded that the 1959 **Physical Society Exhibition of Scientific Instruments and Apparatus** will be held at the Royal Horticultural Society's Old and New Halls, Westminster, London, S.W.1, on Tuesday, Wednesday and Thursday, January 20 to 22. On the first day the opening hours will be from 10 a.m. to 9 p.m., on the second day from 10 a.m. to 7 p.m., and on the third day from 10 a.m. to 4.30 p.m.

Polish Zircon Sands

It is reported from Poland that in recent months the Polish non-ferrous metals industry has been undertaking trial exploitation of zircon sands on the Baltic coast. Beaches in the region of the Hel Peninsula contain significant quantities of various minerals potentially useful

to industry, including ilmenite, magnetite, and garnet. For some years now, similar sands on the East German Baltic coastline have been exploited for industrial purposes.

A Birmingham Event

A sales conference was held in Birmingham recently by **W. Canning and Company Ltd.,** and was attended by sales staff and executives from Birmingham, London and Sheffield. The conclusion of the conference was marked by a dinner at the Queen's Hotel, Birmingham, at which Sir Ernest Canning, chairman of the company, presided.

A Seasonal Appeal

All commercial travellers will be familiar with the work of the **Royal Commercial Travellers' Schools,** at Pinner, Middlesex. The doors of these schools have remained open since the year 1845, and have helped over 5,000 children of travellers who have become incapacitated, or for any other reason of misfortune or distress have needed the schools.

The board of management now issue an appeal for funds to enable the good work of these schools to be continued, and an excellent folder has been prepared showing the general work of the schools and their present financial position. These folders can be obtained from the secretary to the schools at 161 Uxbridge Road, Hatch End, Middlesex.

Non-Ferrous Club

At the December luncheon meeting of **The Non-Ferrous Club** last week, at the Queen's Hotel, Birmingham, the guest speaker was the Marquess of Hertford, who gave a most interesting talk about his home, Ragley Hall, which was opened to the public this year.

The usual collection taken at this luncheon meeting amounted to £25, and this was given to The Birmingham Post and Mail Christmas Tree Fund.

West German Aluminium

Statistics recently issued in Düsseldorf show that West German production of virgin aluminium is forecast at 135,000 tons this year, about 20,000 tons less than in 1957. From February 1 to October 31 it was 116,473 tons, 11 per cent less than in the same period of 1957. The decline in domestic production is attributed to higher imports, put at 65,000 tons for the year against almost 40,000 tons in 1957.

Branch Offices

Two new branch offices are being opened by **Martonair Limited.** One is in Birmingham, at 46 Great Hampton Street, comprising a showroom, stockroom and office, in charge of Mr. R. A. Young, and the other is an office and stockroom at the Central Administration Building, Team Valley, Gateshead, 11. This office is in charge of Mr. C. P. White.

Institute of Physics

Early notice is given of two important events to be held next year under the auspices of the **Institute of Physics.** The first is a one-day Symposium entitled "Current Developments in the Production of High Vacua," to take place in London on April 17, 1959. There will be three sessions—(a) chemical and ionic pumping in kinetic vacuum systems, (b) problems in the production of high vacua in large equipment, and (c) analysis of residual gases in kinetic vacuum systems.

The second event is a conference on "Some Aspects of Magnetism," which will be held in Sheffield from September 22-24, 1959. The subjects to be covered by the conference are:—(a) fundamental theories of ferro-, ferri-, and antiferromagnetism, including magnetic structure; (b) theories of technical magnetization processes, including hysteresis, coercivity, anisotrophy and directional effects; (c) theoretical and experimental studies of domain phenomena in bulk materials and thin films; and (d) experimental and theoretical studies of antiferromagnetism in metals and non-metals.

Full particulars of both these events may be obtained from the secretary of the Institute at 47 Belgrave Square, London, S.W.1.

At the dinner concluding the sales conference of W. Canning and Company Limited

New Welsh Branch

News from the Chamberlain Group is that **Chamberlain Plant Ltd.** is opening up a branch depot at Milford Haven to handle the increasing contractors' plant hire side of the business developing in that area. This new depot will be under the control of Mr. B. F. Stevens, who has been with the company for 20 years. The company states that its whole range of contractors' plant, including Staffa mobile and shop cranes and Jenbach compressors, for which it is the distributor, is also available through the Milford Haven depot.

Welding Technology

It has been announced by the **Institute of Welding** that two courses are being offered by the School of Welding Technology during the next two months.

From January 12-16 a course on training, testing and approval of welders; and from February 9-13 a course on brazing technology and design is to be held. A further course is to be held in February dealing with welded storage tanks.

Full details regarding these courses may be obtained from the Secretary to the Institute at 54 Princes Gate, Exhibition Road, London, S.W.7.

Japanese Rolled Aluminium

Statistics issued by the Japan Light Metals Association show that both the output and deliveries of rolled aluminium products in October hit post-war highs at 6,003 and 6,058 metric tons respectively. A winter increase was usual, but this increase was general throughout the year.

Export contracts during October increased sharply to 730·6 metric tons compared with 481·7 in September, but export shipments during October decreased slightly to 411·5 metric tons compared with 428·2 in September.

Iron Founders' Tribute

At a dinner held in London on Monday last, members of the iron founding industry paid tribute to **Dr. J. G. Pearce** on the occasion of his retirement as director of the British Cast Iron Research Association since its infancy in 1924.

During the course of the function tributes were paid to Dr. Pearce by **Dr. Harold Hartley,** former chairman of Radiation Ltd., and by **Mr. E. Player,** President of the association and managing director of Birmid Industries Ltd. From small beginnings in a single room in New Street, Birmingham, the association had now grown, the meeting was reminded, to a major research centre of international standing with an annual income, of over £200,000 and with a membership of more than 1,300. Dr. Pearce was also one of the main sponsors of the National Foundry College, at Wolverhampton.

U.K. Metal Stocks

Stocks of refined tin in London Metal Exchange warehouses amounted to 16,383 tons, and were distributed as follows at the end of last week:—London 5,993; Liverpool 8,870;, and Hull 1,520.

Stocks of refined copper totalled 5,946 tons, distributed in warehouses as follows: London 4,075; Liverpool 1,621; and Manchester 250.

Soviet Mining

Writing in a Moscow journal, the Acting Minister for Geological Research of the Soviet Union, Boris Yerofediev, stated that such large deposits of aluminium-bearing materials had been found in the European section of the Soviet Union, in western Siberia, the Krasnoyarsk area, Armenia and Azerbaidjan, that the U.S.S.R. would be able to raise its output of this metal 2·8 times by 1965.

Turkish Copper

News from Istanbul states that Turkey has completed the civil engineering of her new electrolytic copper plant and that the installation of the machinery and equipment has begun. It is expected that the plant—which will have an annual output capacity of some 4,000 metric tons—will

begin operating early next year. It is also anticipated that the plant's production will cover Turkey's requirements for electrolytic copper.

World Tin Statistics

World mine production of tin-in-concentrates in September, 1958, increased to 11,300 tons, according to the International Tin Council. Output in Malaya and Nigeria was lower than in August, but Bolivian production increased sharply, and production in Indonesia and the Belgian Congo also rose. World mine output in the third quarter of 1958 amounted to 31,500 tons, compared with 32,500 tons in the previous quarter and 43,600 tons in the third quarter of 1957.

World consumption of primary tin metal in September, 1958, is estimated to have amounted to 12,700 tons, the highest monthly figure since October of last year. U.K. consumption rose to 1,784 tons, also the highest since October, 1957. Consumption in the U.S., at 4,350 tons, was the highest since September, 1957. Estimated world consumption in the third quarter of 1958 was 36,900 tons, of which the U.S. accounted for 12,555 tons and the U.K. for 4,852 tons.

U.S. Aluminium Scrap

Domestic consumption of purchased aluminium-base scrap in July, 1958, totalled 25,054 short tons, according to the Bureau of Mines, United States Department of the Interior. While scrap use was at the same level as in June, output of finished ingot increased about 1,500 tons, and shipments of ingot were up 1,400 tons.

Independent smelters used 75 per cent (18,678 tons) of the total purchased scrap reported used in July. Primary producers used 16 per cent (4,106 tons), and foundries, fabricators and other consumers 9 per cent (2,270 tons). The calculated metallic recovery totalled 20,803 tons; 16,570 tons from new scrap and 4,233 tons from old scrap. The Bureau estimates full coverage of the industry would show total scrap consumption of 29,000 tons and ingot production of 20,000 tons. Metallic recovery based on full coverage would total 24,000 tons.

Metal Finishing

Some 40 members of the **Metal Finishing Association** met on Tuesday of this week for a luncheon at the Blue Gate Hotel, Smethwick. On this occasion—the first luncheon of the season—there was no guest speaker. The chairman, Mr. C. Wharrad, welcomed the guests and announced that there would be a meeting in February, probably, but details would be announced later.

A London Function

An informal dinner was given by the **Institution of Metallurgists** at the Imperial College, London, last week, for their President, Mr. W. E. Ballard. This event took place in the Ayrton Hall of the College, in which a small exhibition of silver, including the British Jewellers' Association Rose Bowl, had been arranged by Miss Dorothy Pile on behalf of the B.J.A.

New Sciaky Unit

A miniature oscilloscope has recently been produced by **Sciaky Electric Welding Machines Limited.** This unit weighs only 5 lb. and the makers state that it is uncomplicated and inexpensive. It operates from a 230 V 50 cycles supply, ±10 per cent variation in voltage, and has been designed for automatic focusing. Provision had been made for switching the circuit signal direct to the "x" plate via the attenuated network and blocking condenser. The brilliance control is variable to facilitate the study of diverse waveforms.

There is an even simpler version of this instrument for direct installation in associated electronic equipment, which facilitates the location of a fault by the customer and enables him to seek technical advice without having to call in the services of a maintenance engineer.

An Order from Russia

Reports from Worcestershire state that the **Bronx Engineering Company Ltd.** has secured a £40,000 contract from Soviet Russia for the supply of eight tube-straightening machines to the Russian Stanko Import Organization.

Scrap Metal Lectures

A course of eight lectures has been arranged to be given in the Department of Metallurgy, College of Technology, Birmingham, on the subject of **"Technological Aspects of the Non-Ferrous Scrap Metal Industry,"** to commence on Wednesday, January 28 next. The lectures will be given in the evenings and are intended for technical staff engaged in the non-ferrous scrap metals industry, and will comprise broad surveys of the various sections of the industry. In addition to a lecture, there will be opportunity for discussion and questions.

The opening lecture will be given by Dr. I. G. Slater, Head of the Department of Metallurgy at the College, on "Metallurgical Background of the Non-Ferrous Scrap Metal Industry," and the other seven lectures will be given by personalities in the industry to cover the following sections:—(a) copper and copper-base alloys; (b) light alloys; (c) other non-ferrous metals and alloys, including lead, tin, zinc, and nickel; (d) the sampling of non-ferrous scrap materials, their analyses and the control techniques commonly used (in two parts); (e) principles involved in the sorting, melting, refining and casting of scrap metals; and (f) commercial practice in the non-ferrous scrap metal trade.

The fee for admission to the course is £2 2s. 0d., and application should be made on a special form, which may be obtained from the Metallurgy Department, College of Technology, Gosta Green, Birmingham, 4.

Metallurgical Essay Competition

As in past years, the **Birmingham Metallurgical Society** offers the award of the Society's Medal for the best essay on a metallurgical topic submitted by a student. In addition to this award, students who submit essays of sufficient merit may receive one of the other prizes that have been made available for this competition.

There is no set subject for the competition, but it is suggested that competitors may find the most suitable subject in that branch of metallurgy with which they are most familiar in their work or study. The competition is open to students of metallurgy who are not more than 25 years of age and are studying, or have studied, at a technical college in Warwickshire, Worcestershire or Staffordshire, or at the University of Birmingham.

Full details of this competition may be obtained from the secretary to the society, c/o Brown Bayley Steels Ltd., 21 Bennetts Hill, Birmingham, 2. Entries must be sent not later than February 2 next. In addition to the individual awards, the **Dorothy Pile Trophy** will be awarded to, and held for one year by, the institute responsible for training the recipient of the Society's Medal. This award is intended to serve as an acknowledgment of the part played by that institute in training the successful student.

A Safety Film

In a new safety film, entitled "The Human Factor," shown in London this week by **Imperial Chemical Industries Limited,** an accompanying note states that the company is working towards an accident frequency rate of 0·25 for every 100,000 hours' work. This year, the company says, the accident rate is down to 0·44, although in 1946 it was just under 3·0.

Induction Heating Process

A demonstration of gear cutting and induction hardening was recently given by **Charles Churchill and Company Ltd.** at their premises in Birmingham. The demonstration showed the production of gears by this induction heating process. The gear teeth were hobbed from prepared blanks on the Churchill rigid hobber. Designed to preserve all the proved Churchill-Cleveland features, but with increased rigidity and power, this machine, it is stated, will meet all possible future needs for hobbing at still higher feeds and speeds.

In its redesigned form this machine has a reduced operating height, and facilities for the inclusion of semi-automatic and fully automatic tooling set-ups. Its floor area of only 22½ ft² shows a great space-saving advantage.

Metal Market News

THERE can be no doubt that at the present time tin is easily the winner among the four base metals in any comparison on the basis of stability, for so far in December, with a slightly rising tendency, the price has hovered around £760. Not that a lot of change has taken place in the others, but relatively and actually the fluctuations are greater. For the second week running, L.M.E. tin stocks were lower at the beginning of last week, a fall of 283 tons bringing the total down to 17,073 tons. The turnover was about 670 tons, and the market closed £6 higher on balance at £762 cash and £761 10s. 0d. three months. Generally, it would seem that a fairly bullish view is being taken of the prospects for this metal, and in some directions the price is talked up to £780. Business was not particularly brisk in any direction last week, but this is hardly surprising in view of the approach of Christmas, but it certainly does seem that sentiment on both sides of the Atlantic is better than it was. The American recession, if not a thing of the past entirely and forgotten, has, nevertheless, been replaced by a well-sustained recovery, and indications are not lacking that on this side of the Atlantic we have turned the corner of the depression. It seems now that the United States Government is bent on continuing the quota system for lead and zinc for some months, and maybe longer than that.

Wall Street staged a remarkably good session in mid-week, and the Metal Market in London took heart from this, for all quotations registered advances on Thursday. The backwardation in zinc is now fully £4, and the prompt price of this metal is £3 or so over that of lead, but in the forward position the situation is reversed. Prompt zinc is certainly scarce, but there seems to be some idea that the American quotas are pretty well exhausted for the moment, and the supply position may improve. In lead, the position is rather different, for prompt and forward metal are quoted level. There is certainly no lack of supplies, and in the States the stocks of this metal have been increasing. Business is only moderately good, a condition which is reflected in the modest turnover on the London Metal Exchange. Business in standard copper, on the other hand, last week was pretty brisk, and the turnover, without Kerb trading, amounted to 11,325 tons, which, of course, included carries. L.M.E. warehouse stocks were reported 475 tons lower at 5,996 tons, but no backwardation appeared till the second half of the week. The tone was steady and the trend rather upwards, although on Tuesday at midday cash copper dropped to £216. From this low point, £4 under the previous day, the market rallied to £222 15s. 0d. on Thursday. The close on Friday afternoon, at £221 5s. 0d. for cash and £220 15s. 0d. three months, showed a gain of 15s. in cash and a drop of 5s. in three months. On the Kerb, a rather firmer tone was in evidence.

Zinc and lead were both pretty active, although demand for the former is reported as not being particularly good. On the Metal Exchange, the turnover in zinc was quite impressive, for it exceeded 8,000 tons during the week. On balance there was not a lot of change, for December, at £74 15s. 0d., was 5s. up, while March, at £70 15s. 0d., showed a loss of 15s. The backwardation increased by £1 to £4, reflecting the continuing scarcity of early metal, for which, at the moment, there does not seem to be a cure. In lead, some 6,575 tons changed hands, the market closing at £71 12s. 6d. both positions, with a loss of £1 12s. 6d. in December and of £1 17s. 6d. in March. Demand from consumers has not been very good, and the decline in Whittington Avenue reflects this state of affairs.

New York

Over last week-end the undertone of copper has been steady. Futures copper was moderately higher on some covering and new buying. The custom smelter price continued split at $28\frac{1}{2}$ to 29 cents a lb., with at least one $28\frac{1}{2}$ cents seller reporting modest sales. Producer copper was quiet, but this partly reflects the fact that two major producers have not yet started selling copper for January. Tin was quiet and steady. Lead and zinc were quiet.

A Government official is reported as having indicated that lead and zinc import quotas would probably remain in effect for at least a year.

Paris

In a statement to shareholders, Pechiney announced that, despite the recession in the United States and the falling-off of sales in France itself, also due to recession, increased exports enabled the company to keep its factories running at normal production speed. It stated, however, that competition on foreign markets was becoming more and more difficult. The first eight months of this year equalled exports for the whole of 1957, despite this fact. Further, the company intends expanding. A new aluminium plant will be started at Nogueres-Moreux. It will have a production capacity of 50,000 tons per year. In Marseilles, special warehouses have been opened for the storage of alumina which will enable the metal to be exported loose and without packing.

In Africa, production is normal. The Cameroon plant at Edea is still producing to capacity, that is, 4,000 tons per month. Development in Guinea, which recently voted for independence, will not be arrested, and an agreement between the Guinea Government and the French Government has been reached on this matter.

Finally, the statement makes it quite clear that the company is not worried by the start of the Common Market in January. It says that quality of French aluminium is equal to any, but it does stress that France may be hindered on the market by the high rate of social security charges.

Pechiney has reached agreement with the Yugoslav alumina plants at Kidricevo and Lozovac whereby the French company will give the Yugoslavs technical assistance. Pechiney will aid the Yugoslavs in the production of electrolytic aluminium, and it is expected that production at Kidricevo, because of this, will rise from 45,000 tons to 92,000 tons per year without considerable investments being necessary.

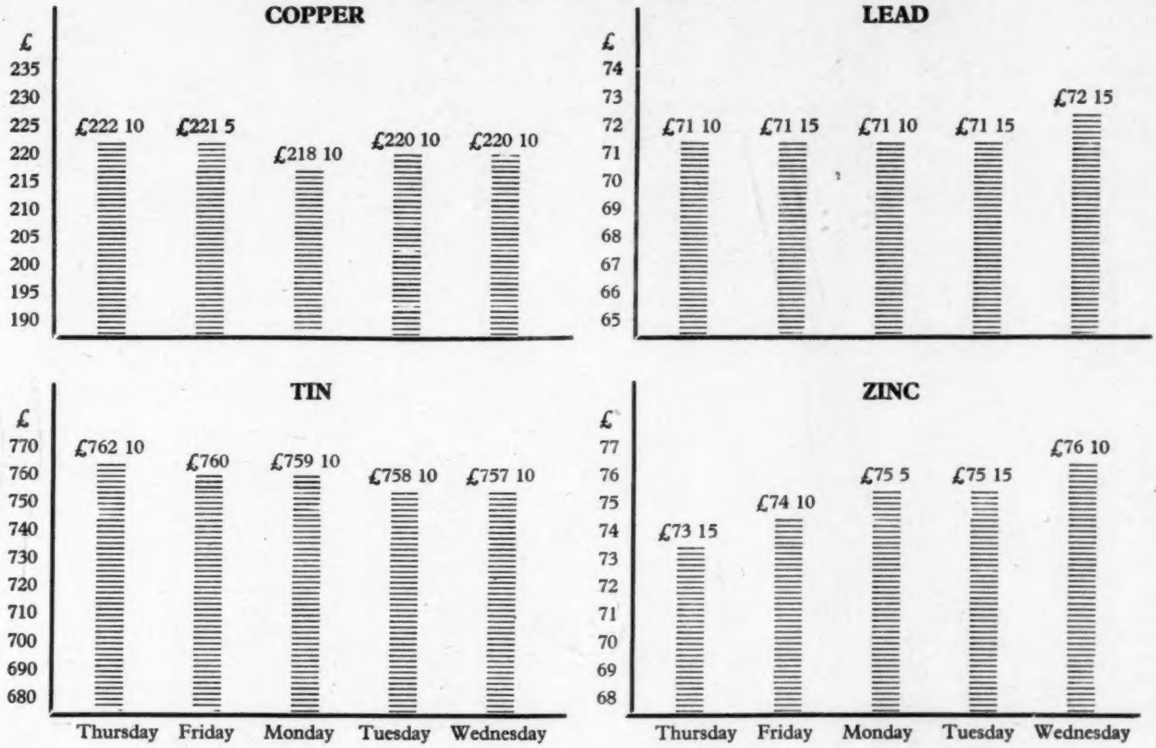
Birmingham

With Christmas only a few days away, business in the metal trades has become even quieter than it has been in the last few weeks. Works will be closed for three or four days and stocktaking will follow. Industry has been encouraged by the welcome news of an improvement in exports last month, particularly as this follows a period of several months in which decline had been noticed. Expansion has been notable in the North American area, chiefly because of substantial exports of motor vehicles. Good business is being done by the makers of heavy electrical equipment used in the fitting out of power stations, both at home and abroad. Only a small increase in unemployment took place in Midland industry last month, but a good deal of short time is being worked. The exception is in the motor trade, which continues to provide work for many component firms.

Steel consumers continue to buy in small quantities to meet immediate needs. Demand for sheets provides full employment at some mills which cater for the motor trade. There is also a steady demand for heavy plates, although pressure for supplies has declined generally over the past twelve months. Many iron foundries are working short time due to lack of orders, but firms making heavy engineering castings are more favourably situated. Re-rolling steel mills are operating below capacity. Supplies of pig iron and scrap are more than sufficient to cover requirements. Activity is maintained amongst builders of railway rolling stock.

METAL PRICE CHANGES

LONDON METAL EXCHANGE, Thursday 11 December 1958 to Wednesday 17 December 1958



OVERSEAS PRICES

Latest available quotations for non-ferrous metals with approximate sterling equivalents based on current exchange rates

	Belgium fr/kg ≏ £/ton		Canada c/lb ≏ £/ton		France fr/kg ≏ £/ton		Italy lire/kg ≏ £/ton		Switzerland fr/kg ≏ £/ton		United States c/lb ≏ £/ton	
Aluminium			22.50	185 17 6	210	182 15	375	217 10	2.50	209 0	26.80	214 10
Antimony 99.0					195	169 12 6	445	256 2 6			29.00	232 0
Cadmium					1,500	1,305 0					145.00	1,160 0
Copper												
Crude												
Wire bars 99.9							435	252 7 6				
Electrolytic	30.75	224 15	28.00	231 5	268	233 2 6			3.15	263 10 0	29.00	232 0
Lead			11.75	97 0	115	100 0	176	102 0	.95	79 10 0	13.00	104 0
Magnesium												
Nickel			70.00	578 5	900	783 0 0	1,300	754 0	7.50	627 2 6	74.00	592 0
Tin	106.75	780 7 6			940	817 17 6	1,460	846 17 6	9.00	752 10	99.12	793 0
Zinc												
Prime western			11.50	95 0 0							11.50	92 0
High grade 99.95			12.10	100 0 0								
High grade 99.99			12.50	103 5 0								
Thermic					107.12	93 2 6						
Electrolytic					115.12	100 2 6	175	101 10	.93	75 5	12.75	102 0

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NON-FERROUS METAL PRICES

(All prices quoted are those available at 2 p.m. 17/12/58)

PRIMARY METALS

		£	s.	d.
Aluminium Ingots	ton	180	0	0
Antimony 99·6%	„	197	0	0
Antimony Metal 99%	„	190	0	0
Antimony Oxide	„	180	0	0
Antimony Sulphide Lump	„	190	0	0
Antimony Sulphide Black Powder	„	205	0	0
Arsenic	„	400	0	0
Bismuth 99·95%	lb.		16	0
Cadmium 99·9%	„		9	6
Calcium	„	2	0	0
Cerium 99%	„	16	0	0
Chromium	„		6	11
Cobalt	„		16	0
Columbite per unit			—	
Copper H.C. Electro	ton	220	10	0
Fire Refined 99·70%	„	219	0	0
Fire Refined 99·50%	„	218	0	0
Copper Sulphate	„	74	0	0
Germanium	grm.		—	
Gold	oz.	12	10	3
Indium	„		10	0
Iridium	„	20	0	0
Lanthanum	grm.		15	0
Lead English	ton	72	15	0
Magnesium Ingots	lb.		2	5½
Notched Bar	„		2	10½
Powder Grade 4	„		6	3
Alloy Ingot, A8 or AZ91	„		2	8
Manganese Metal	ton	290	0	0
Mercury	flask	74	0	0
Molybdenum	lb.	1	10	0
Nickel	ton	600	0	0
F. Shot	lb.		5	5
F. Ingot	„		5	6
Osmium	oz.		nom.	
Osmiridium	„		nom.	
Palladium	„	5	15	0
Platinum	„	19	10	0
Rhodium	„	40	0	0
Ruthenium	„	15	0	0
Selenium	lb.		nom.	
Silicon 98%	ton		nom.	
Silver Spot Bars	oz.		6	3⅞
Tellurium	lb.		15	0
Tin	ton	757	10	0
***Zinc**				
Electrolytic	ton		—	
Min 99·99%	„		—	
Virgin Min 98%	„	74	10	0
Dust 95/97%	„	109	0	0
Dust 98/99%	„	115	0	0
Granulated 99+%	„	99	10	0
Granulated 99·99+%	„	114	7	6

**Duty and Carriage to customers' works for buyers' account.*

INGOT METALS

Aluminium Alloy (Virgin)		£	s.	d.
B.S. 1490 L.M.5	ton	210	0	0
B.S. 1490 L.M.6	„	202	0	0
B.S. 1490 L.M.7	„	216	0	0
B.S. 1490 L.M.8	„	203	0	0
B.S. 1490 L.M.9	„	203	0	0
B.S. 1490 L.M.10	„	221	0	0
B.S. 1490 L.M.11	„	215	0	0
B.S. 1490 L.M.12	„	223	0	0
B.S. 1490 L.M.13	„	216	0	0
B.S. 1490 L.M.14	„	224	0	0
B.S. 1490 L.M.15	„	210	0	0
B.S. 1490 L.M.16	„	206	0	0
B.S. 1490 L.M.18	„	203	0	0
B.S. 1490 L.M.22	„	210	0	0

		£	s.	d.
†Aluminium Alloys (Secondary)				
B.S. 1490 L.M.1	ton	142	10	0
B.S. 1490 L.M.2	„	152	0	0
B.S. 1490 L.M.4	„	169	0	0
B.S. 1490 L.M.6	„	186	0	0

†Average selling prices for mid October

		£	s.	d.
***Aluminium Bronze**				
BSS 1400 AB.1	ton	221	0	0
BSS 1400 AB.2	„	238	0	0
***Brass**				
BSS 1400-B3 65/35	„	142	0	0
BSS 249	„		—	
BSS 1400-B6 85/15	„		—	
***Gunmetal**				
R.C.H. 3/4% ton	„		—	
(85/5/5/5)	„	178	0	0
(86/7/5/2)	„	188	0	0
(88/10/2/1)	„	240	0	0
(88/10/2/½)	„	249	0	0
Manganese Bronze				
BSS 1400 HTB1	„	181	0	0
BSS 1400 HTB2	„	200	0	0
BSS 1400 HTB3	„		—	
Nickel Silver				
Casting Quality 12%	„		nom.	
„ „ 16%	„		nom.	
„ „ 18%	„		nom.	
***Phosphor Bronze**				
B.S. 1400 P.B.1 (A.I.D. released)	„	269	0	0
B.S. 1400 L.P.B.1	„	203	0	0
Phosphor Copper				
10%	„	233	0	0
15%	„	237	0	0

**Average prices for the last week-end.*

		£	s.	d.
Phosphor Tin				
5%	ton		—	
Silicon Bronze				
BSS 1400-SB1	„		—	
Solder, soft, BSS 219				
Grade C Tinmans	„	355	6	0
Grade D Plumbers	„	286	9	0
Grade M	„	390	0	0
Solder, Brazing, BSS 1845				
Type 8 (Granulated)	lb.		—	
Type 9 „	„		—	
Zinc Alloys				
Mazak III	ton	107	12	6
Mazak V	„	111	12	6
Kayem	„	117	12	6
Kayem II	„	123	12	6
Sodium-Zinc	lb.		2	6½

SEMI-FABRICATED PRODUCTS

Prices of all semi-fabricated products vary according to dimensions and quantities. The following are the basis prices for certain specific products.

Aluminium		£	s.	d.
Sheet 10 S.W.G.	lb.		2	8½
Sheet 18 S.W.G.	„		2	10½
Sheet 24 S.W.G.	„		3	1½
Strip 10 S.W.G.	„		2	8½
Strip 18 S.W.G.	„		2	9½
Strip 24 S.W.G.	„		2	11
Circles 22 S.W.G.	„		3	2½
Circles 18 S.W.G.	„		3	1½
Circles 12 S.W.G.	„		3	0½
Plate as rolled	„		2	8
Sections	„		3	2
Wire 10 S.W.G.	„		2	11½
Tubes 1 in. o.d. 16 S.W.G.	„		4	1

		£	s.	d.
Aluminium Alloys				
BS1470. HS10W.	lb.			
Sheet 10 S.W.G.	„		3	1
Sheet 18 S.W.G.	„		3	3½
Sheet 24 S.W.G.	„		3	11
Strip 10 S.W.G.	„		3	1
Strip 18 S.W.G.	„		3	2½
Strip 24 S.W.G.	„		3	10½
BS1477. HP30M.				
Plate as rolled	„		2	11
BS1470. HC15WP.				
Sheet 10 S.W.G.	„		3	9½
Sheet 18 S.W.G.	„		4	2
Sheet 24 S.W.G.	„		5	0½
Strip 10 S.W.G.	„		3	10½
Strip 18 S.W.G.	„		4	2
Strip 24 S.W.G.	„		4	9½
BS1477. HPC15WP.				
Plate heat treated	„		3	6½
BS1475. HG10W.				
Wire 10 S.W.G.	„		3	10½
BS1471. HT10WP.				
Tubes 1 in. o.d. 16 S.W.G.	„		5	0½
BS1476. HE10WP.				
Sections	„		3	1½
Beryllium Copper				
Strip	„	1	4	11
Rod	„	1	1	6
Wire	„	1	4	9
Brass Tubes	„		1	8⅞
Brazed Tubes	„		—	
Drawn Strip Sections	„		—	
Sheet	ton		—	
Strip	„	241	10	0
Extruded Bar	lb.		1	11¼
Extruded Bar (Pure Metal Basis)	„		—	
Condenser Plate (Yellow Metal)	ton	177	0	0
Condenser Plate (Naval Brass)	„	189	0	0
Wire	lb.		2	5⅜
Copper Tubes	lb.		2	1⅜
Sheet	ton	247	10	0
Strip	„	247	10	0
Plain Plates	„		—	
Locomotive Rods	„		—	
H.C. Wire	„	272	15	0
Cupro Nickel				
Tubes 70/30	lb.		3	5⅜
Lead Pipes (London)	ton	112	5	0
Sheets (London)	„	110	0	0
Tellurium Lead	„	£6 extra		
Nickel Silver				
Sheet and Strip 7%	lb.		3	6½
Wire 10%	„		4	1½
Phosphor Bronze				
Wire	„		3	11½

Titanium (1,000 lb. lots)			
Billet over 4″ dia.-18″ dia.	lb.	63/-	64/-
Rod 4″ dia.-·250″ dia.	„	75/-	112/-
Wire under ·250″ dia.-·036″ dia.	„	146/-	222/-
Sheet 8′ × 2′ × ·250″-·010″ thick	„	88/-	157/-
Strip ·048″-·003″ thick	„	100/-	350/-
Tube (representative gauge)	„		300/-
Extrusions	„		120/-

		£	s.	d.
Zinc Sheets, English destinations	ton	108	5	0
Strip	„		nom.	

Scrap Metal Prices

Merchants' average buying prices delivered, per ton, 16/12/58.

	£
Aluminium	
New Cuttings	142
Old Rolled	120
Segregated Turnings	90
Brass	
Cuttings	131
Rod Ends	125
Heavy Yellow	103
Light	98
Rolled	121
Collected Scrap	100
Turnings	120
Copper	
Wire	182
Firebox, cut up	175
Heavy	171
Light	165
Cuttings	182
Turnings	161
Braziery	139
Gunmetal	
Gear Wheels	168
Admiralty	168
Commercial	145
Turnings	140
Lead	
Scrap	61
Nickel	
Cuttings	—
Anodes	500
Phosphor Bronze	
Scrap	145
Turnings	140
Zinc	
Remelted	54
Cuttings	42
Old Zinc	31

The latest available scrap prices quoted on foreign markets are as follow. (The figures in brackets give the English equivalents in £1 per ton):—

West Germany (D-marks per 100 kilos):		
Used copper wire	(£182.15.0)	210
Heavy copper	(£182.15.0)	210
Light copper	(£152.5.0)	175
Heavy brass	(£104.10.0)	120
Light brass	(£82.12.6)	95
Soft lead scrap	(£58.5.0)	67
Zinc scrap	(£38.5.0)	44
Used aluminium unsorted	(£87.0.0)	100
France (francs per kilo):		
Copper	(£204.10.0)	235
Heavy copper	(£204.10.0)	235
Light brass	(£134.17.6)	155
Zinc castings	(£58.5.0)	67
Lead	(£81.15.0)	94
Tin		—
Aluminium	(£117.10.0)	135
Italy (lire per kilo):		
Aluminium soft sheet clippings (new)	(£194.7.6)	335
Aluminium copper alloy	(£124.15.0)	215
Lead, soft, first quality	(£83.10.0)	144
Lead, battery plates	(£47.10.0)	82
Copper, first grade	(£200.2.6)	345
Copper, second grade	(£188.10.0)	325
Bronze, first quality machinery	(£197.5.0)	340
Bronze, commercial gunmetal	(£168.5.0)	290
Brass, heavy	(£136.7.6)	235
Brass, light	(£124.15.0)	215
Brass, bar turnings	(£127.12.6)	220
New zinc sheet clippings	(£58.0.0)	100
Old zinc	(£43.10.0)	75

Financial News

McKechnie Bros. Ltd.

In the chairman's statement at the annual general meeting of the company, held on Monday last, the hope was expressed that the improvement in the company's activities shown during the past year would be maintained during this present year. In the year to end-July last, this group of non-ferrous metal and heavy chemical manufacturers regained £234,700 of the £614,900 drop in total profits suffered in 1956-57. On the chemicals side prospects are considered uncertain, but in the case of metals the outlook is generally favourable, while the current year's results will also have the aid of a new subsidiary, African-French Metals—from which material benefits are expected—and of new factory premises, as well as recent heavy capital outlays. In 1956-57 and 1957-58, £845,000 and £833,000 respectively was spent on fixed assets; £779,000 of this represents expenditure on the new factory. Furthermore, capital commitments at the end-July last were £174,000 greater at £442,000, while apart from the drive to reduce manufacturing costs a great deal of promising development work is at present in progress.

Northern Aluminium Co. Ltd.

According to city news, the Northern Aluminium Company Limited is proposing to raise £6m. new capital. The company will, it is said, issue three million £1 Ordinary shares and £3m. 6 per cent debenture stock, 1975-83. The parent company—Aluminium Limited—is stated to have already subscribed this year for 1¼ million of the Ordinary shares. The new capital is to be used for the expenditure programme over the next three years.

Goodlass Wall

It is reported that Goodlass Wall and Lead Industries Ltd. have acquired the entire share capital of St. Helens Smelting Company.

An Acquisition

It has been announced by the directors of Concentric Manufacturing Company Limited that they have completed the purchase of the whole of the issued share capital of Alexander Controls Limited, a company engaged in the business of manufacturing solenoid valves, electronic and scientific instruments for use in automatic equipment and atomic energy projects.

The vendors have received as purchase consideration the sum of £42,000 in cash and an allotment of 130,000 Ordinary shares of 2s. each, fully paid, in Concentric Manufacturing Co. Limited. These shares will not be entitled to the final dividend for the year ended September 30, 1958, or to the special interim dividend of 2d. per share for the year ending 30th September, 1959, but will otherwise rank *pari passu* with the other Ordinary shares of the company.

It is proposed to apply, in the near future, for quotation and permission to deal in respect of the new shares now issued. The business of Alexander Controls Limited will continue to be carried on under the same management which has been engaged in electronic developments for many years.

Mr. S. G. Morgan and Mr. H. Burke have joined the board of Alexander Controls Limited.

Trade Publications

Pressure Die Casting.—High Duty Alloys Ltd., Slough, Bucks.

A useful little folder gives some details of the services rendered by this company in pressure die-casting in Hiduminium. Some notes on typical pressure die-casting alloys are given, together with specifications, physical properties, etc. There are also several illustrations of finished components.

Laboratory Apparatus.—Johnson, Matthey and Company Ltd., 73-83 Hatton Garden, London, E.C.1.

One of the latest publications from this company is that (No. 1700) dealing with platinum laboratory apparatus, and which revises and combines the earlier booklets 1710 and 1720. The booklet is divided into two sections, one dealing with chemical apparatus and the other with electrochemical apparatus. There are over 40 pages in the book, containing much statistical data and many illustrations.

Degreasing Plant. — Imperial Chemical Industries Limited, Imperial Chemical House, Millbank, London, S.W.1.

A new booklet, entitled Trichloroethylene Degreasing Plant Type E" has just been issued by this company. The object of this booklet is to introduce a standard range of totally enclosed mechanized plants. The work handling capacity of the new plants and the choice of treatments available is sufficiently flexible to enable them to deal with a wide variety of industrial metal degreasing problems.

Tools and Supplies.—Buck and Hickman Ltd., 2-8 Whitechapel Road, London, E.1.

Well over 1,200 pages comprises the 1958 general catalogue of small tools and supplies just published by this company. Designs and technical details have been carefully revised, and as far as possible the list prices have been adjusted. A section is devoted to formulae and tables which will be found particularly useful for reference to many shop problems. Detailed equivalents in inches and millimetres, English and Metric weights and measures, conversion factors, decimal equivalents of all gauges in general use, formulae for screw threads, pipe flanges, copper tubes, etc., and mensuration formulae are given, together with much additional information.

Metal Melting.—W. J. Hooker Ltd., 239A Finchley Road, London, N.W.3.

A four-page leaflet describes the Radyne Hookercaster, which has been designed to melt all metals from light alloys to gold and silver, and through the range of non-ferrous metals up to steel and platinum. Details of the melting unit are given, the specification of the machine, other useful data, and illustrations of the complete unit.

THE STOCK EXCHANGE

Considerable Buying Continued in Industrial Share Market

ISSUED CAPITAL •	AMOUNT OF SHARE	NAME OF COMPANY	MIDDLE PRICE 16 DECEMBER +RISE —FALL		DIV. FOR LAST FIN. YEAR	DIV. FOR PREV. YEAR	DIV. YIELD	1958 HIGH	1958 LOW	1957 HIGH	1957 LOW
£	£				Per cent	Per cent					
4,435,792	1	Amalgamated Metal Corporation ...	23/6		9	10	7 13 3	24/9	17/6	28/3	18/–
400,000	2/–	Anti-Attrition Metal	1/7½		4	8½	4 18 6	1/9	1/3	2/6	1/6
38,305,038	Stk. (£1)	Associated Electrical Industries ...	58/–	+6d.	15	15	5 3 6	58/6	46/6	72/3	47/9
1,590,000	1	Birfield	56/6		15	15	5 6 3	62/4½	46/3	70/–	48/9
3,196,667	1	Birmid Industries	66/9	+1/9	17½	17½	5 4 9	77/6	55/3	80/6	55/9
5,630,344	Stk. (£1)	Birmingham Small Arms	35/6	+3d.	11	10	6 4 0	37/3	23/9	33/–	21/9
203,150	Stk. (£1)	Ditto Cum. A. Pref. 5%	15/–		5	5	6 13 3	16/1½	14/7½	16/–	15/–
350,580	Stk. (£1)	Ditto Cum. B. Pref. 6%	17/1½		6	6	7 0 3	17/4½	16/6	19/–	16/6
500,000	1	Bolton (Thos.) & Sons	26/9		10	12½	7 9 6	28/9	24/–	30/3	28/9
300,000	1	Ditto Pref. 5%	15/–		5	5	6 13 3	16/–	15/–	16/9	14/3
160,000	1	Booth (James) & Co. Cum. Pref. 7%	19/6xd		7	7	7 3 6	20/4½	19/–	22/3	18/9
9,000,000	Stk. (£1)	British Aluminium Co.	72/–	+1/9	12	12	3 6 9	74/–	36/6	72/–	38/3
1,500,000	Stk. (£1)	Ditto Pref. 6%	19/6		6	6	6 3 0	20/–	18/4½	21/6	18/–
15,000,000	Stk. (£1)	British Insulated Callender's Cables	51/3	+1/9	12½	12½	4 17 6	52/–	38/9	55/–	40/–
17,047,166	Stk. (£1)	British Oxygen Co. Ltd., Ord. ...	44/3	—3d.	10	10	4 10 6	47/–	28/3	39/–	29/6
600,000	Stk. (5/–)	Canning (W.) & Co.	24/6	+3d.	25+ *2½C	25	5 2 0	24/6	19/7½	24/6	19/3
60,484	1/–	Carr (Chas.)	1/3		25	25	20 0 0	2/3	1/4½	3/6	2/1½
150,000	2/–	Case (Alfred) & Co. Ltd.	4/9xd	+1½d.	25	25	10 5 3	5/3	4/–	4/6	4/–
555,000	1	Clifford (Chas.) Ltd.	21/6		10	10	9 6 0	21/3	16/–	20/6	15/9
45,000	1	Ditto Cum. Pref. 6%	15/3xd		6	6	7 17 6	16/–	15/–	17/6	16/–
250,000	2/–	Coley Metals	3/–		20	25	13 6 9	4/6	2/6	5/7½	3/9
8,730,596	1	Cons. Zinc Corp.†	59/6	+3/3	18¾	22½	6 6 0	59/6	41/–	92/6	49/–
1,136,233	1	Davy & United	84/3	+2/6	20	15	4 15 0	84/3	45/9	60/6	42/6
2,750.000	5/–	Delta Metal	24/7½	+1½d.	30	*17½	6 1 9	25/–	17/7½	28/6	19/–
4,160,000	Stk. (£1)	Enfield Rolling Mills Ltd.	34/6		12½	15B	7 5 0	38/–	22/9	38/6	25/–
750,000	1	Evered & Co.	30/–	+2/–	15Z	15	6 13 3	30/–	26/–	52/9	42/–
18,000,000	Stk. (£1)	General Electric Co.	39/3	+1/9	10	12½	5 2 0	39/6	29/6	59/–	38/–
1,500,000	Stk. (10/–)	General Refractories Ltd.	36/3		20	17½	5 10 3	39/3	27/3	37/–	26/9
401,240	1	Gibbons (Dudley) Ltd.	66/6xd		15	15	4 10 3	67/6	61/–	71/–	53/–
750,000	5/–	Glacier Metal Co. Ltd.	7/3		11¼	11¼	7 18 6	8/3	5/–	8/1½	5/10½
1,750,000	5/–	Glynwed Tubes	16/–	—3d.	20	20	6 5 0	18/1½	12/10½	18/–	12/6
5,421,049	10/–	Goodlass Wall & Lead Industries ...	30/–	+6d.	13‖	18Z	4 6 9	30/–	17/3	37/3	28/9
342,195	1	Greenwood & Batley	57/6		20	17½	6 19 3	57/9	45/–	50/–	46/–
396,000	5/–	Harrison (B'ham) Ord.	15/4½	—1½d.	*15	*15	4 17 6	15/9	11/6	16/9	12/4½
150,000	1	Ditto Cum. Pref. 7%	19/6xd		7	7	7 3 6	19/9	18/4½	22/3	18/7½
1,075,167	5/–	Heenan Group	7/9	+4½d.	10	10‡	6 9 0	9/7¾	6/9	10/4½	6/9
236,953,260	Stk. (£1)	Imperial Chemical Industries ...	36/–	—3d.	12Z	10	4 9 0	36/7½	27/7½	46/6	36/3
33,708,769	Stk. (£1)	Ditto Cum. Pref. 5%	16/9xd		5	5	5 19 6	17/1½	16/–	18/6	15/6
14,584,025	**	International Nickel	157½	+2¾	$2.60	$3.75	2 19 0	169	132¾	222	130
430,000	5/–	Jenks (E. P.), Ltd.	9/9xd	+6d.	14	27½ϕ	7 3 6	9/9	6/7½	18/10½	15/1½
300,000	1	Johnson, Matthey & Co. Cum. Pref. 5%	15/7½		5	5	6 8 0	16/9	15/–	17/–	14/6
3,987,435	1	Ditto Ord.	45/3		10	10	4 8 6	47/–	36/6	58/9	40/–
600.000	10/–	Keith, Blackman	28/9		17½	15	6 1 9	28/9	15/–	21/9	15/–
160,000	4/–	London Aluminium	5/6xd	+1½d.	10	10	7 5 6	5/6	3/–	6/9	3/6
2,400,000	1	London Elec. Wire & Smith's Ord. ...	60/–	—1/–	12½	12½	4 3 3	64/6	39/9	54/6	41/–
400,000	1	Ditto Pref.	23/7½		7½	7½	6 7 0	24/3	22/–	25/3	21/9
765,012	1	McKechnie Brothers Ord.	45/–		15	15	6 13 3	45/–	32/–	48/9	37/6
1,530,024	1	Ditto A Ord.	45/–		15	15	6 13 3	45/–	30/–	47/6	36/–
1,108,268	5/–	Manganese Bronze & Brass	13/–	—1½d.	20	27½‡	7 13 9	14/1½	8/9	21/10½	7/6
50,628	6/–	Ditto (7½% N.C. Pref.)	6/–		7½	7½	7 10 0	6/3	5/6	6/6	5/–
13,098,855	Stk. (£1)	Metal Box	68/6xd	+2/3	11	11	3 4 3	68/6	40/6	59/–	40/3
415.760	Stk. (2/–)	Metal Traders	8/9	—3d.	50	50	11 8 6	9/–	6/3	8/–	6/3
160,000	1	Mint (The) Birmingham	20/6	+6d.	10	10	9 15 0	22/9	19/–	25/–	21/6
80,000	5	Ditto Pref. 6%	70/6		6	6	8 10 3	83/6	70/6	90/6	83/6
3,705 670	Stk. (£1)	Morgan Crucible A	43/–		10	10	4 13 0	45/–	34/–	54/–	35/–
1.000,000	Stk. (£1)	Ditto 5½% Cum. 1st Pref. ...	17/6		5½	5½	6 5 9	18/–	17/–	19/3	16/–
2,200,000	Stk (£1)	Murex	52/–	—6d.	17½	20	6 14 3	58/9	47/9	79/9	57/–
468,000	5/–	Ratcliffs (Great Bridge)	11/–	+6d.	10	10	4 11 0	11/1½	6/10½	8/–	6/10½
234,960	10/–	Sanderson Bros. & Newbould ...	27/3		20	27½D	7 6 9	27/3	24/6	41/–	24/9
1,365,000	Stk. (5/–)	Serck	18/–		15	17½	4 2 3	18/4½	11/–	18/10½	11/6
6,698,586	Stk. (£1)	Stone-Platt Industries	44/–	+1/–	15	12½	6 16 3	44/6	22/6	33/4½	22/7½
2,928,963	Stk. (£1)	Ditto 5½% Cum. Pref.	16/3		5½	5½	6 15 6	16/3	12/7½	14/–	12/9
14,494,862	Stk. (£1)	Tube Investments Ord.	78/6	+6d.	17½	15	4 9 3	78/9	48/4½	70/9	50/6
41,000,000	Stk. (£1)	Vickers	34/6	+3d.	10	10	5 16 0	36/3	28/9	46/–	29/–
750,000	Stk (£1)	Ditto Pref. 5%	15/6		5	5	6 9 0	15/9	14/3	18/–	14/–
6,863,807	Stk. (£1)	Ditto Pref. 5% tax free	22/–		*5	*5	7 0 3A	23/–	21/3	24/9	20/7½
2,200,000	1	Ward (Thos. W.), Ord.	84/–	+1/–	20	15	4 15 3	87/3	70/9	83/–	64/–
2,665,034	Stk. (£1)	Westinghouse Brake	43/6	+1/6	10	18P	4 12 0	43/6	32/6	85/–	29/1½
225,000	2/–	Wolverhampton Die-Casting ...	9/–xd	+3d.	30	25	6 13 3	10/1½	7/–	10/1½	7/–
591,000	5/–	Wolverhampton Metal	21/3	+9d.	27½	27½	6 9 6	22/9	14/9	22/3	14/9
78,465	2/6	Wright, Bindley & Gell	5/4½	+7½d.	20	20	9 6 0	5/4½	2/9	3/9	2/7½
124,140	1	Ditto Cum. Pref. 6%	12/9xd		6	6	9 8 3	13/–	11/3	12/6	11/3
150,000	1/–	Zinc Alloy Rust Proof	2/9		27	40D	9 16 3	3/1½	2/7½	5/–	2/9

*Dividend paid free of Income Tax. †Incorporating Zinc Corpn. & Imperial Smelting. **Shares of no Par Value. ‡ and 100% Capitalized issue. • The figures given relate to the issue quoted in the third column. A Calculated on £7 14 6 gross. Y Calculated on 11½% dividend. ‖Adjusted to allow for capitalization issue. E for 15 months. P and 100% capitalized issue, also "rights" issue of 2 new shares at 35/– per share for £3 stock held. D and 50% capitalized issue. Z and 50% capitalized issue. B equivalent to 12½% on existing Ordinary Capital after 100% capitalized issue. ϕ And 100% capitalized issue. X Calculated on 17½%. C Paid out of Capital Profits.